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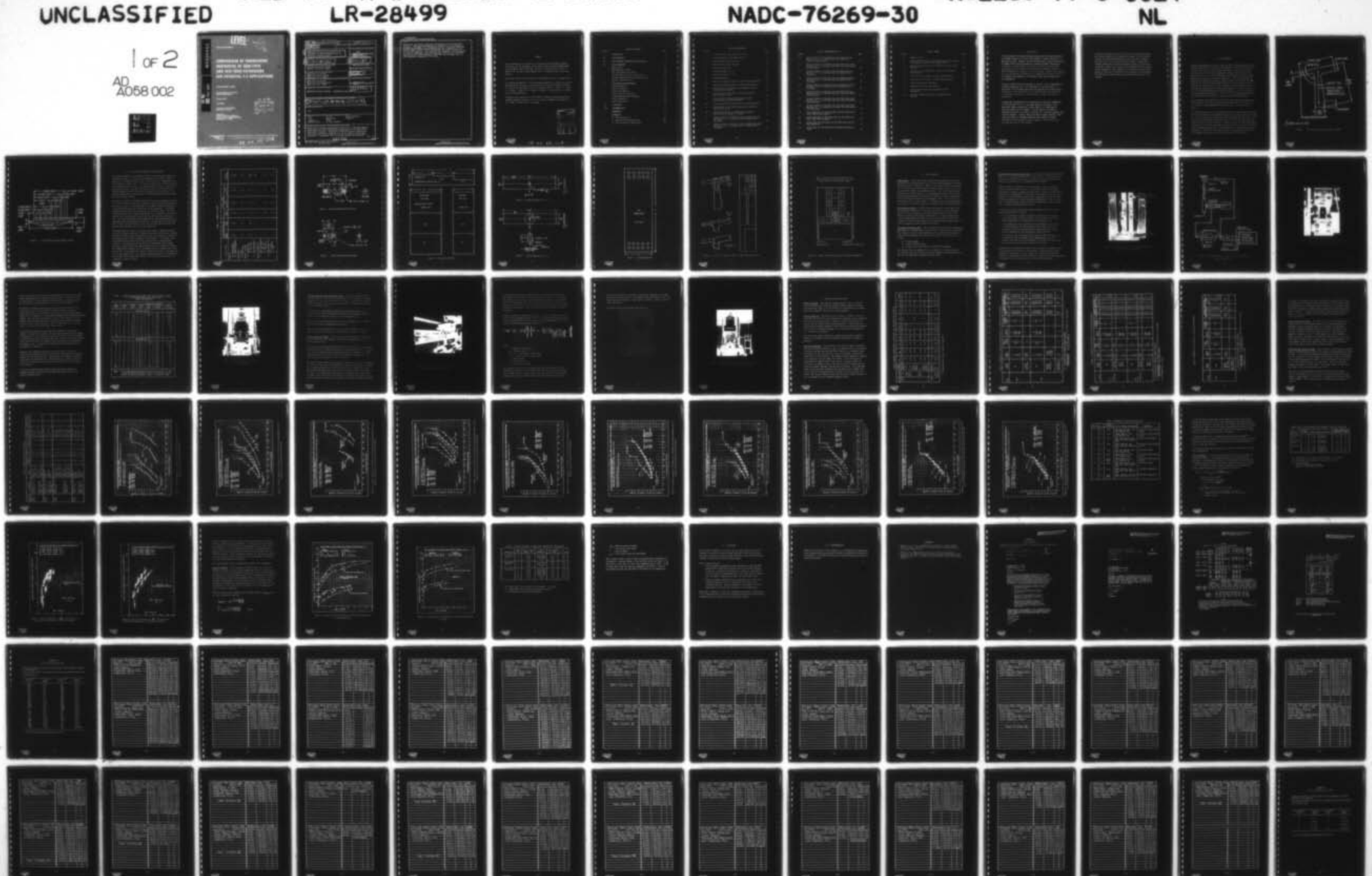

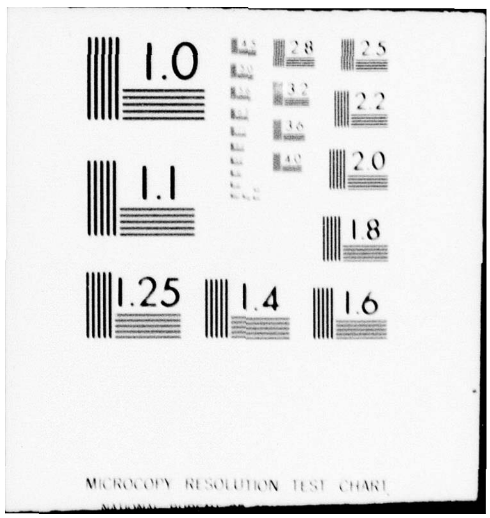
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Report NADC-76269-30

COMPARISON OF ENGINEERING PROPERTIES OF 7050-T7E73 AND 7075-T6510 EXTRUSIONS FOR POTENTIAL P-3 APPLICATIONS

Contract N62269-77-C-0024

Roy W. Brodie and Leon Bakow
Structures and Materials

February 1978

Final Report

Approved for Public Release
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DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
Washington, D. C. 20361

LOCKHEED-CALIFORNIA COMPANY • BURBANK
A DIVISION OF LOCKHEED CORPORATION

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Extruded Shapes	Fracture Toughness	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

7050-T7E73 extrusion material was procured in P-3 wing spar cap and plank shapes for direct comparative testing with current 7075-T6510 production extrusions. Three lots of 7050-T7E73 were produced and processed in production facilities to be representative of actual part fabrication. Comparable 7075-T6 tensile strengths and improved (over)

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exfoliation, and fatigue properties were obtained with the 7050-T7E73 material. Significant improvements were obtained in crack propagation in ≈40% R.H. and ≈98% R.H. environments where the crack growth threshold showed an ≈30% increase and the crack growth rate was ≈67% slower for the 7050-T7E73 material. The 7050-T7E73 also had a 60 to 70% improvement in fracture toughness at room temperature and -65°F over the 7075-T6510 material and the -65°F toughness of 7050-T7E73 was 30% higher than the room temperature toughness of 7075-T6510.

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PREFACE

This investigation was conducted by Lockheed-California Company, Burbank, California, for the Department of the Navy, Naval Air Systems Command/Naval Air Development Center under NADC Contract No. N62269-77-C-0024. Mr. E. Balmuth was the Navy Program Manager and S. J. Barber was the Contracting Officer.

This report covers work performed from 30 November 1976 to 27 February 1978.

The authors are grateful for the assistance provided by A. Chulick for tensile and exfoliation testing, D. Black for spectra fatigue and fracture testing, D. E. Pettit for assistance in fracture analysis and S. T. Chiu, C. T. Clark, S. T. Diggs, J. Ekvall, W. E. Krupp, W. Leuders, L. Silvas, and J. H. Wooley for their contributions.

The authors also appreciate the 7050-T7E73 information and data supplied by Aluminum Company of America, on a no cost basis, through the cooperation of A. S. Kuhns, P. Mehr, and R. B. Shepard.

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I. INTRODUCTION

The high strength 7000 series aluminum alloys have been used extensively in airframe construction due to their strength to weight ratios and low fabrication costs. However, the 7000 series alloys in their high strength T6 temper conditions are susceptible to stress corrosion cracking and exfoliation. An improvement of the stress corrosion and exfoliation resistance of the T6 conditions was obtained by reaging at higher (325 - 350°F) temperatures to produce T73 and T76 tempers. However, this improvement was accompanied by a reduction in strength which prevents 7075-T73 or T76 material from replacing 7075-T6 parts unless lower strengths can be accommodated.

Efforts to retain the static strength of 7075-T6, with an improvement in corrosion resistance led to the development of the 7050 alloy. In particular, 7050 extrusions have shown the potential for being a direct substitute for 7075-T6 extrusions on a strength basis while providing a significant improvement in the resistance to stress corrosion and exfoliation.

Lockheed has considered 7050-T76 extrusions as a potential replacement for the extruded 7075-T6 P-3 wing spar caps and wing skins. This potential caused considerable in-house testing to be performed on various extruded 7050-T76 shapes. The test results confirmed an improved combination of strength, corrosion resistance and toughness over the 7075 material. However, additional data on spectra fatigue, crack growth and fracture toughness properties were needed to provide information for performing structural analyses. The need for these data was the basis for this program.

During the development of the 7050 alloy, the T76 temper extrusions had typical properties which generally exceeded 7075-T6 minimums; however, the established guaranteed tensile and yield strength properties were 2 Ksi below the 7075-T6 minimums. Negotiations between Lockheed and the Aluminum Company of America (Alcoa) were conducted to obtain 7050 extrusions with guaranteed 7075-T6 minimum tensile properties. This resulted in a new temper currently designated as T7E73, which included the 510 stretcher level processing. The extruded 7050-T7E73 material was procured and tested in this program.

II. TEST MATERIALS

Testing was performed on 7075-T6510 and 7050-T7E73 extruded shapes which are currently used for P-3 structural wing components. A wing spar cap shape, LS 9788, shown in Fig. 1 and a wing plank shape, LS 9782, shown in Fig. 2 were selected. The 7075-T6510 shapes were obtained from stock and were produced by Alcoa. The 7050-T7E73 shapes were produced by Alcoa in accordance with the provisions included in Appendix A. The 7050-T7E73 spar cap material was originally produced by Alcoa as 7050-T76510 material for NADC. However, the tensile properties were below the 7075-T6 minimums and the material was returned to the Alcoa's Lafayette, Indiana, Extrusion Plant for reprocessing (heat treating, stretching and aging) to the T7E73 condition. The 7050 wing plank material was processed directly to the T7E73 condition at the Lafayette Extrusion Plant. Two lots of 7050 wing plank material were procured to provide information on material and processing variances.

Some information was supplied by Alcoa on the age stabilizing treatment for 7050 material. The spar cap shape received a final age of 18 hours at 315 to 325°F and the wing planks received a final age of 22 hours at 320 to 330°F.

The mechanical properties of 7050-T7E73 and 7075-T6510 extrusions reported by Alcoa are included with the Lockheed tensile results shown in Tables 4 through 6. The 7075 test report results are listed as Typical Test Report data, since stock is intermixed and the exact test report could not be matched with the pieces used for this test program. In addition to the 7050 test report data, pieces of the 7050-T7E73 wing plank extrusions were sent to Alcoa's Technical Center for additional testing. Data transmitted to Lockheed are contained in Appendix A. These results are also included in the appropriate tables with the Lockheed results and are identified as Alcoa Tech Center data.

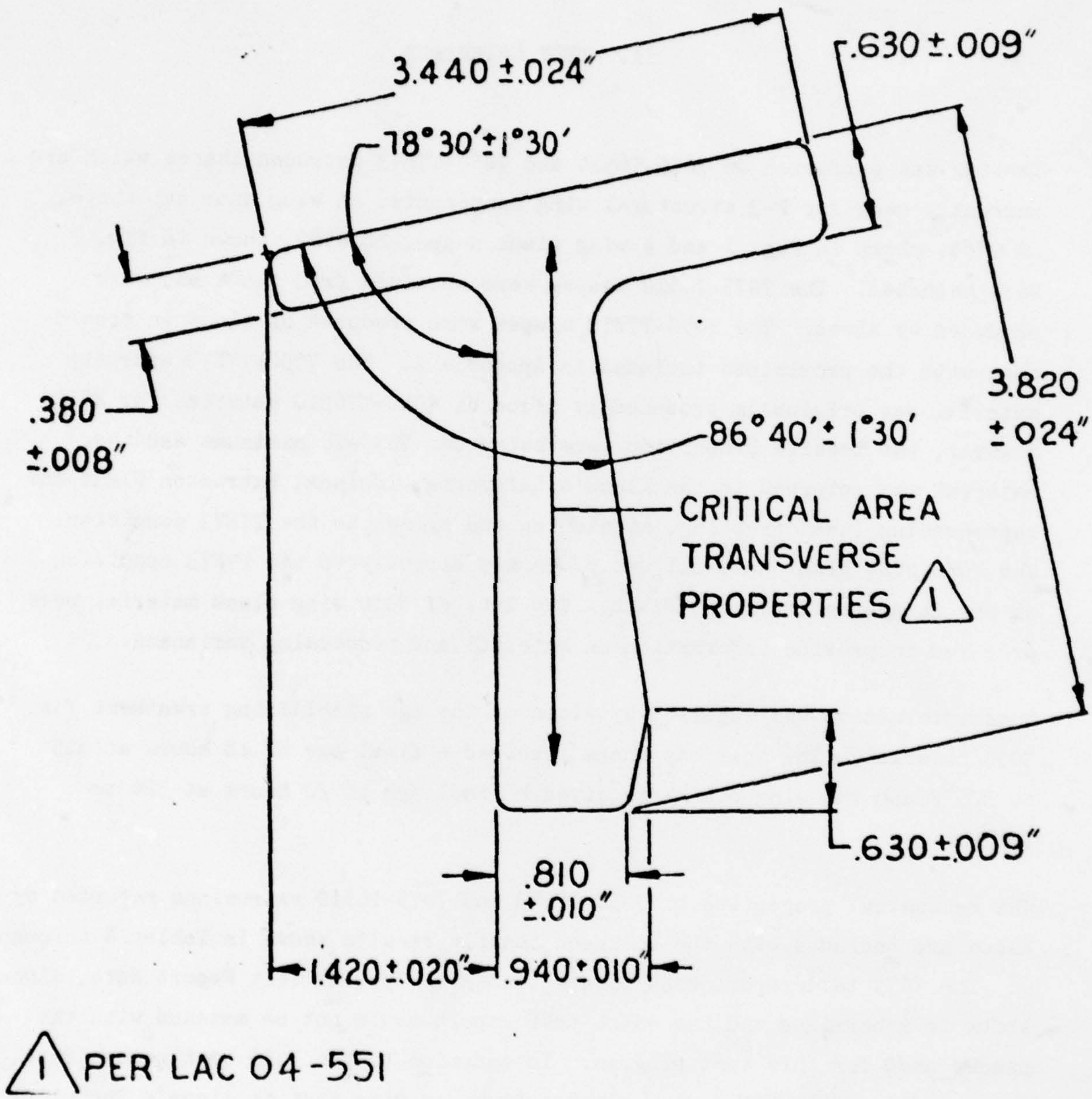

Figure 1 P-3 Extruded Wing Spar Cap Shape, LS 9788

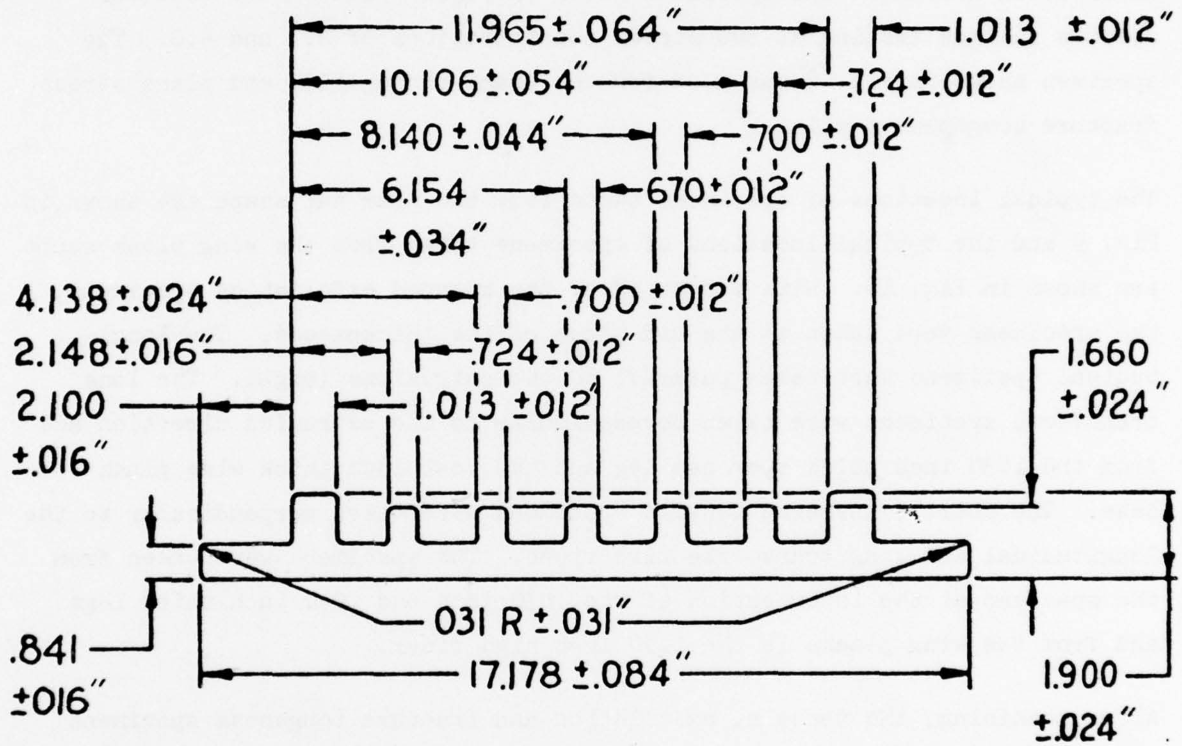

Figure 2 P-3 Extruded Wing Panel Shape, LS 9782

III. TEST SPECIMEN PREPARATION AND PROCESSING

The types and quantities of specimens tested for each material variable are summarized in Table 1. The specimen configurations are shown in Figs. 3 through 8. The specimen shown in Fig. 3 was used for the longitudinal and long transverse tensile tests. The specimen shown in Fig. 4 was used for the short transverse tensile tests. The specimens shown in Fig. 5 were used for exfoliation testing. The specimens shown in Figs. 6 and 7 were used for spectra fatigue testing at two stress concentrations of 2.7 and 4.0. The specimen shown in Fig. 8 was used for the crack propagation and plane stress fracture toughness testing.

The typical locations of specimens taken from the spar cap shape are shown in Fig. 9 and the typical locations of specimens taken from the wing plank shape are shown in Fig. 10. With exception of the stepped exfoliation specimens, the specimens were taken at the mid plane of the thicknesses. The longitudinal specimens were taken parallel to the extrusions length. The long transverse specimens were taken perpendicular to the extrusion direction and from the .630 inch thick spar cap leg and the .841 inch thick wing plank base. The short transverse tensile specimens were taken perpendicular to the longitudinal and long transverse directions. The specimens were taken from the spar cap at the intersection of the .630 inch and .940 inch thick legs and from the wing planks in the 1.90 inch high riser.

After machining, the tensile, exfoliation and fracture toughness specimens received no further processing. Subsequent processing of the spectra fatigue specimens included etching followed by chemical film treatment or saturation shot peening plus etching and chemical film treatment. The fatigue stress concentration notches were drilled and reamed after all processing was completed. This processing was performed in Lockheed-California Company production facilities with the same procedures as used to produce P-3 parts. The chemical film treatment was in accordance with LAC C-0498D(2) which meets MIL-C-5541A. The specimens were given an alkaline etch prior to the application of the chemical film. The saturation shot peening was in accordance with LAC C-1476C(4) which meets MIL-S-13165C. SAE 230 size shot was used at an intensity of 0.003 to 0.008A.

TABLE 1 - SUMMARY OF TESTS

Type of Test	P-3 Wing Spar Cap		P-3 Wing Plank			Total Specimens
	7075-T6510	7050 T7E73	7075 T6510	7050 T7E73 Lot A	7050 T7E73 Lot B	
Tensile						
a) Longitudinal	2	2	2	2	2	10
b) Long Transverse	2	2	2	2	2	10
c) Short Transverse	2	2	2	2	2	10
Exfoliation						
a) EXCO	1	1	1	1	1	5
b) Salt Spray	1	1	1	1	1	5
Spectra Fatigue						
a) Longitudinal						
1) $K_t = 2.7$	4	4	4	4	4	20
2) $K_t = 4.0$	4	4	4	4	4	20
b) Long Transverse						
1) $K_t = 4.0$	-	-	4	4	4	12
Fracture Properties						
a) Crack Propagation						
to 2 a/w ≈ .35	-	-				
1) Lab Air			2	1	1	4
2) Humid Air	-	-	2	1	1	4
b) Plane Stress for 2 a/w ≈.35						
1) Room Temp	-	-	4	2	2	8
2) -65°F	-	-	2	1	1	4

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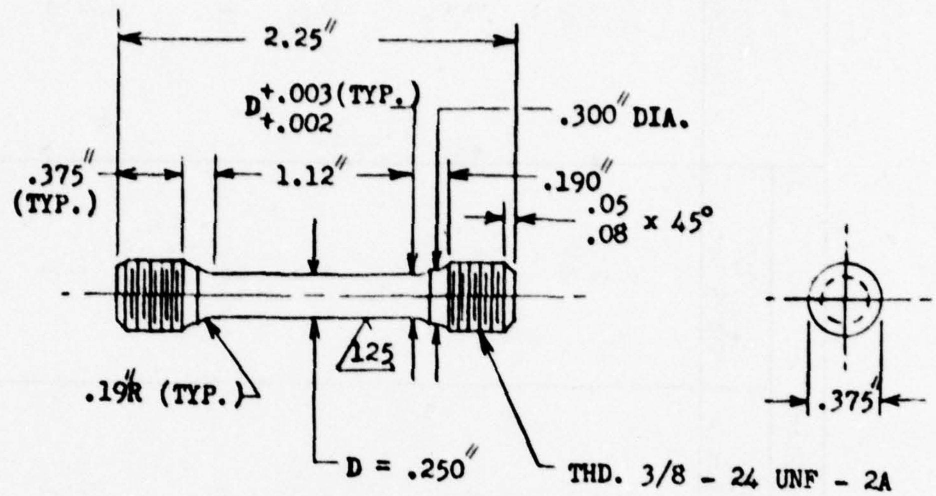


Figure 3 Smooth Standard Tensile Specimen

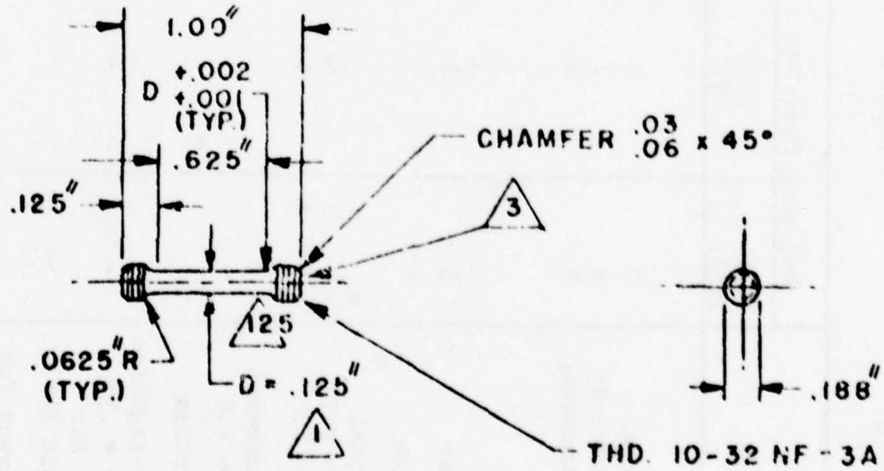


Figure 4 Smooth Subsize Tensile Specimen

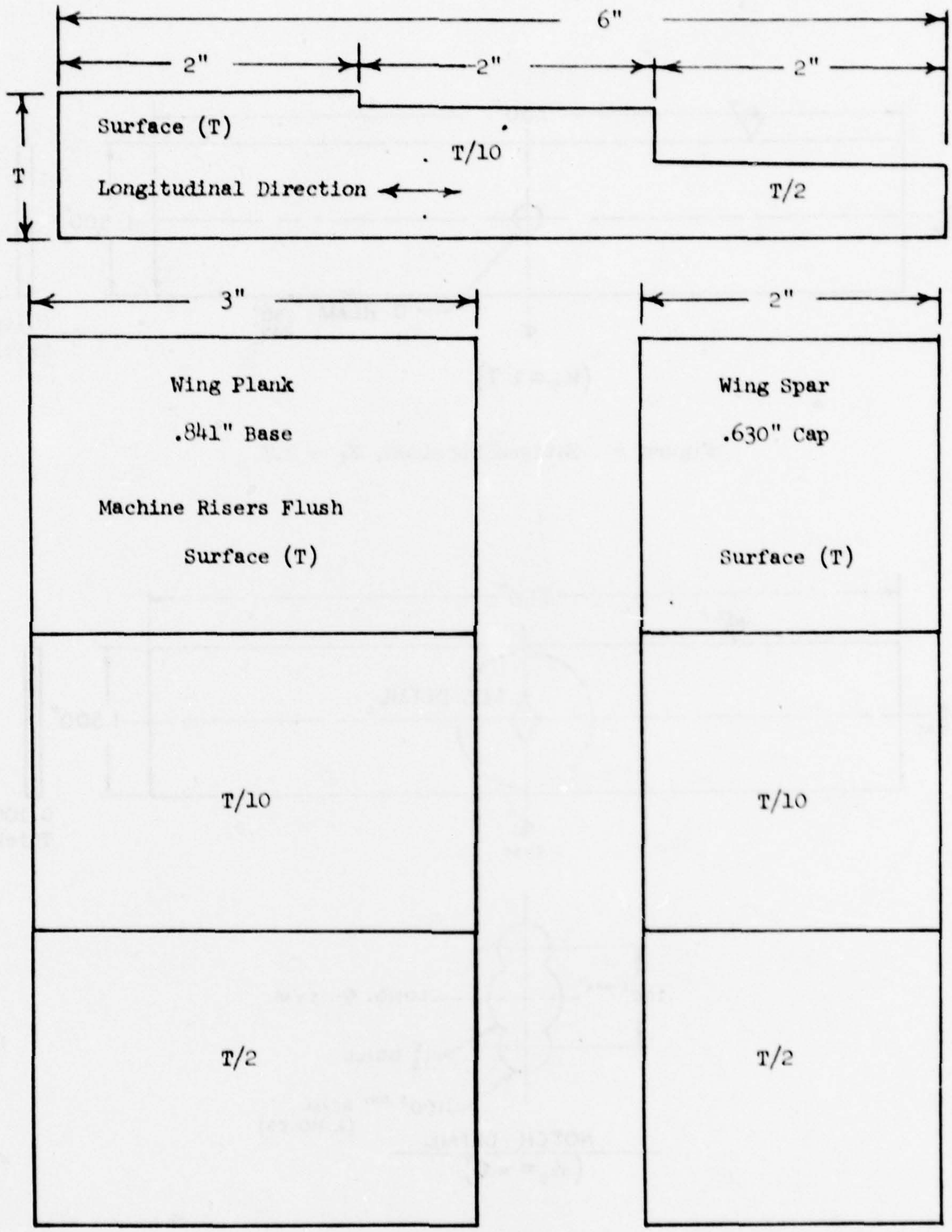


Figure 5 Exfoliation Specimens

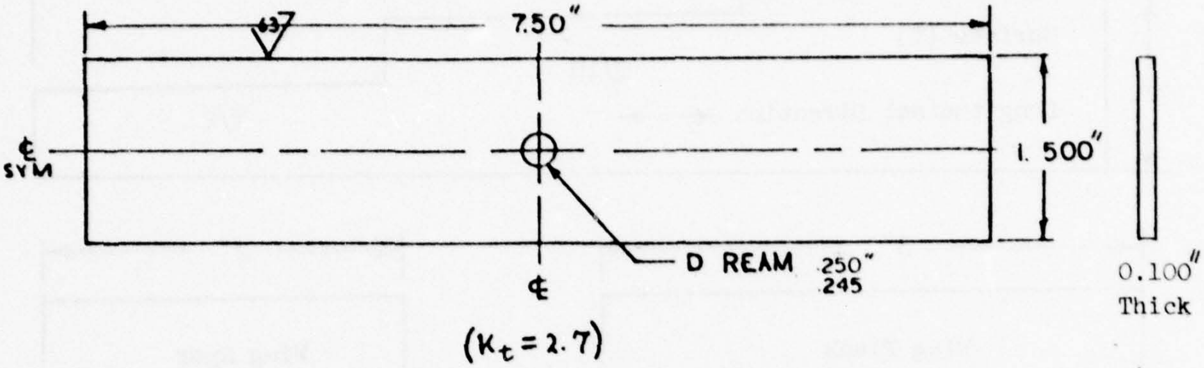


Figure 6 Fatigue Specimen, $K_t = 2.7$

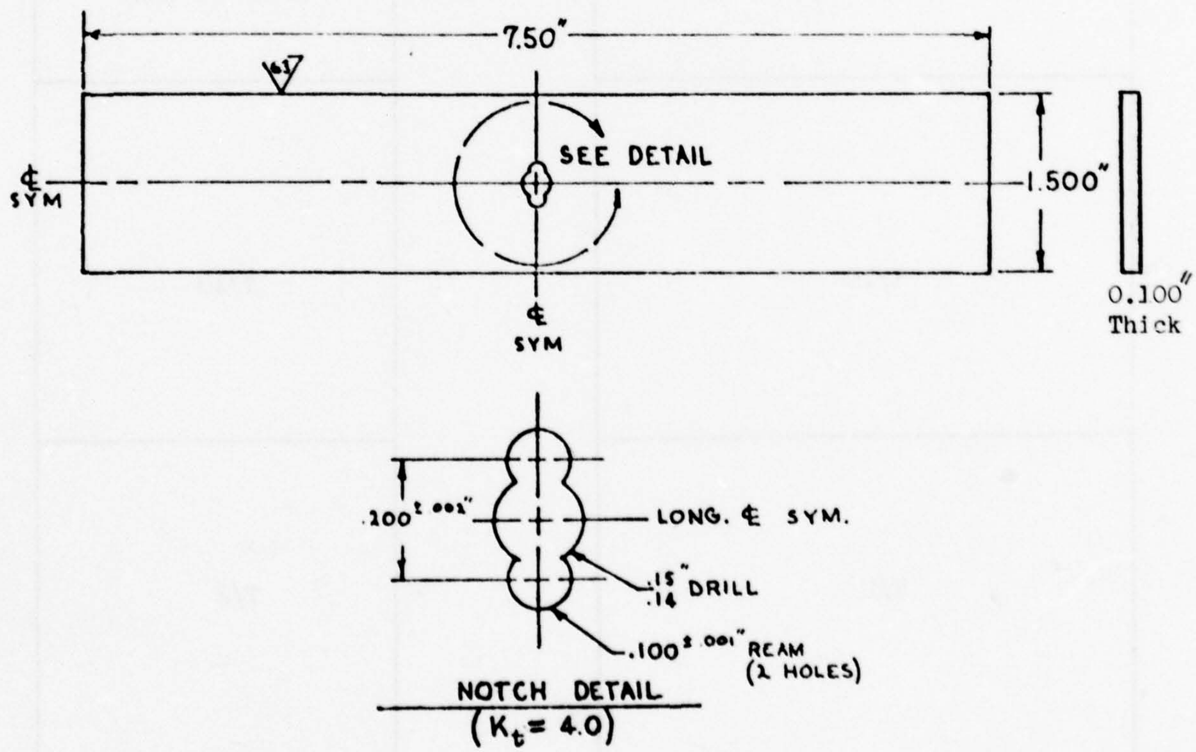


Figure 7 Fatigue Specimen, $K_t = 4.0$

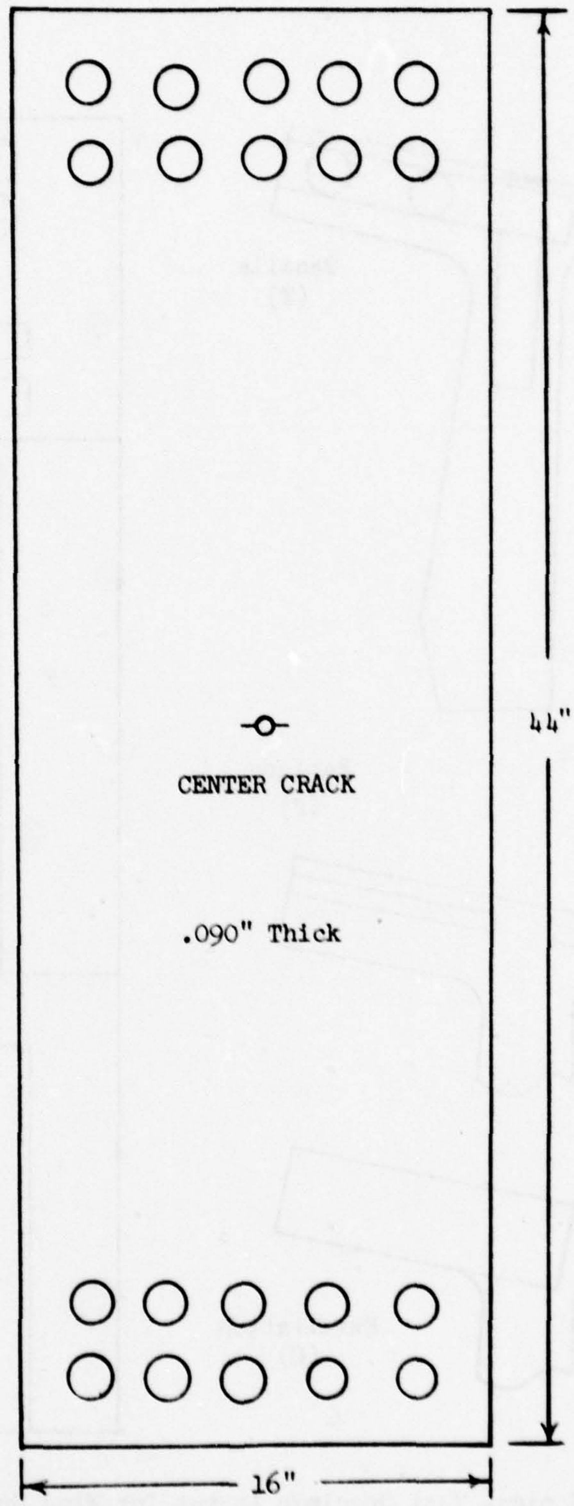


Figure 8 Toughness Specimen

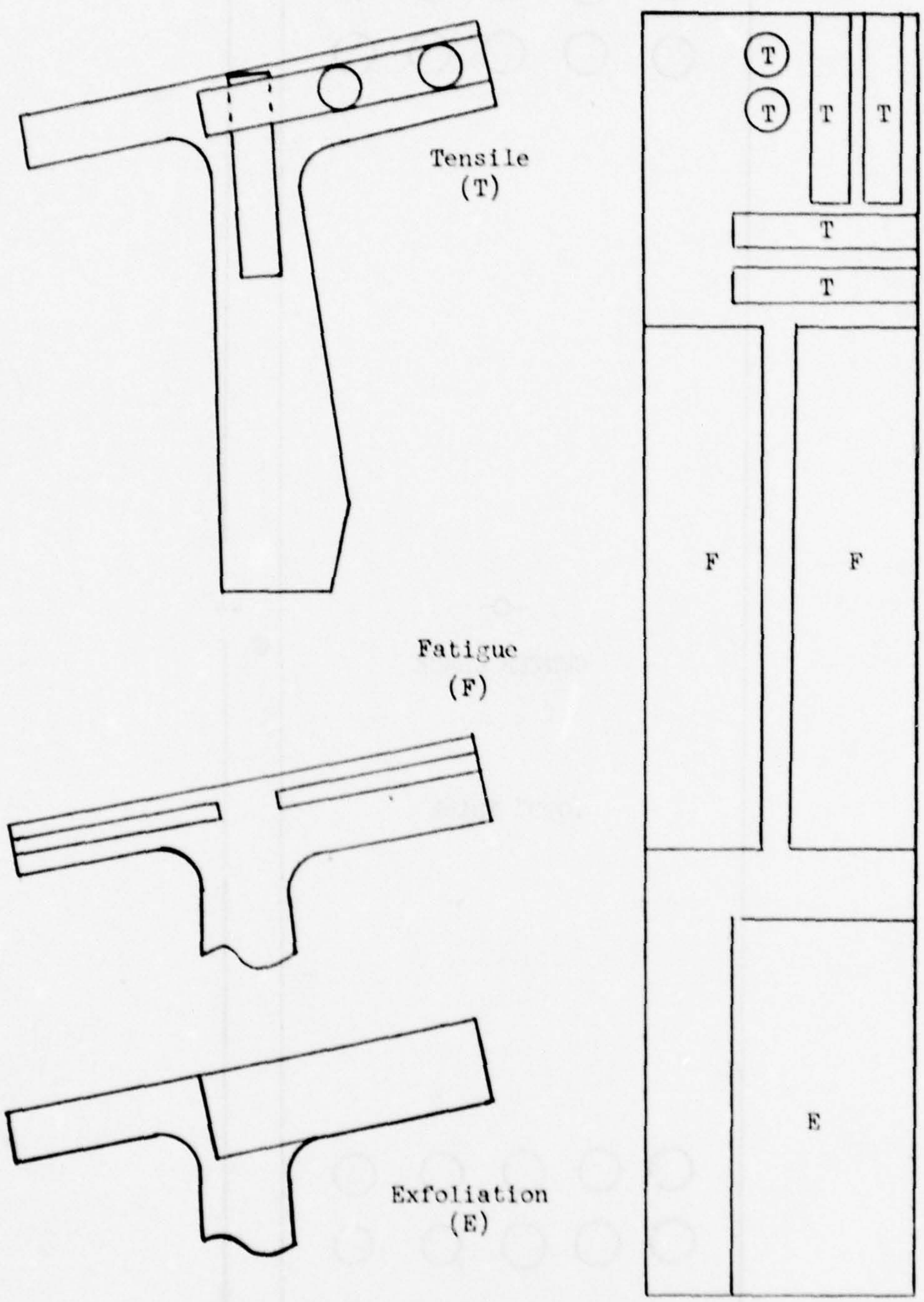
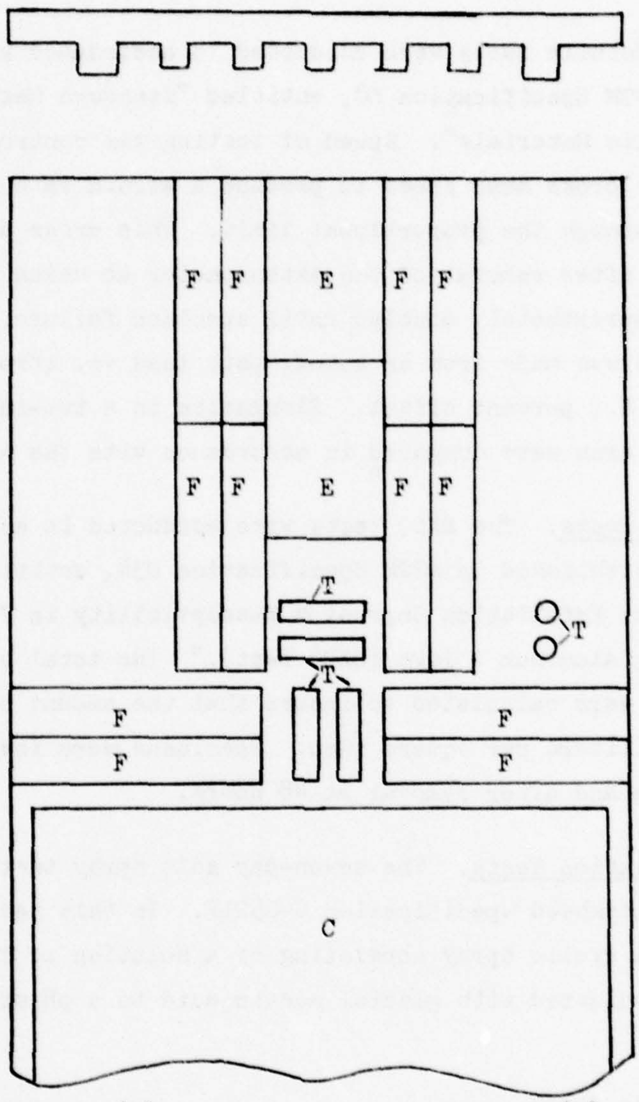


Figure 9 T.pical Test Specimen Layout for Wing Spar Cap Material



Tensile (T) Fatigue (F)
Exfoliation (E) Crack Growth/Toughness (C)

Figure 10 Typical Test Specimen Layout for Wing Plank Material

IV. TEST PROCEDURES

<u>Tensile Tests</u>. Tensile tests were conducted in accordance with procedures established in ASTM Specification E8, entitled "Standard Methods of Tension Testing of Metallic Materials". Speed of testing was controlled by adjustment to a machine cross head speed to produce a strain rate of .005 in. per in. per minute through the proportional limit. This cross head speed was maintained until after removal of the extensometer at which time the cross head speed was approximately doubled until specimen failure. Determination of yield strength was made from an autographic load vs. strain curve and was specified as 0.2 percent offset. Elongation in a two-inch gauge length and reduction of area were computed in accordance with the ASTM procedures.

<u>EXCO Exfoliation Tests</u>. The EXCO tests were conducted in accordance with the procedures established in ASTM Specification G34, entitled "Standard Method of Test for Exfoliation Corrosion Susceptibility in 7XXX Series Copper Containing Aluminum Alloys (EXCO Test)." The total surface areas of the specimens were calculated to insure that the amount of solution exceeded 50 milliliters per square inch. Specimens were inspected after 24 hours of exposure and after ramoval at 48 hours.

<u>Salt Spray Exfoliation Tests</u>. The seven-day salt spray test was conducted in accordance with Lockheed Specification C-0521F. In this test, the specimens were exposed to a cyclic spray consisting of a solution of five percent sodium chloride adjusted with glacial acetic acid to a pH of 3.0 to 3.1 as follows:

a) 45 minute spray
b) 2 hours of dry air purge
c) 3 hours and 15 minute soak at 45-95% relative humidity

The six-hour cycle is repeated for a total period of 7 days (28 cycles). The specimens were then rinsed in water and immersed in concentrated nitric acid at room temperature followed by a water rinse.

Flight-by-Flight Spectra Fatigue Tests. The flight-by-flight spectra fatigue tests of 1.5 inch wide specimens were conducted on two ten thousand pound closed loop electrohydraulic servo controlled test machines which were designed and constructed by the Lockheed-California Company.

Figure 11 shows the installation of two specimens in the test machines, which are numbered channels 3 and 4 and are side-by-side to facilitate monitoring of incipient cracking and crack growth. Figure 12 schematically illustrates the arrangement of a test machine and magnetic tape load programmer. In the installation used in this program, the two machines were in parallel and were run by two independent programmers with only one tape deck. In these machines, loads can be controlled within a scale accuracy of ± 2 percent at frequencies up to 45 Hz.

As indicated in Figure 12 the loading system employed the following safeguards against specimen overload.

1. A load limiter was included to protect the specimens from spurious electrical signals as well as operator error by simply limiting the maximum amplitude of the signals to the pre-selected value.
2. A high-speed dump valve, located across the hydraulic lines between the servo valve and the servo jack protected the specimens from overload in the event of internal valve leakage from the hydraulic pressure reservoir to the high pressure side of the jack.
3. A high-speed relay was located within the servo valve amplifier. In the event the rate of increase in the command signal would have exceeded that which had been programmed, this relay would have locked the servo valve and opened the high-speed dump valve.

Specimens were restrained from buckling under compression loadings by using an anti-buckling bar support on the specimens. Figure 13 shows the bars installed on a specimen. Contact between the specimen and bar support assembly is through teflon and the assembly is installed by finger tightening to preclude any load being carried by the anti-bucking assembly.

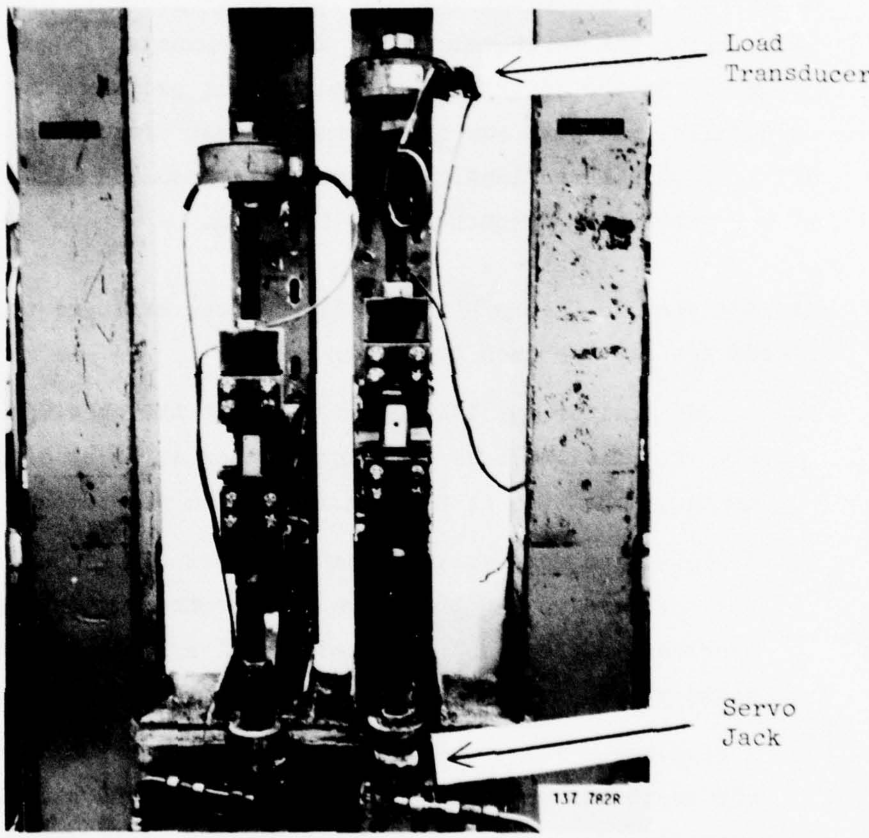


Figure 11 Spectra Fatigue Closed Loop Electro-Hydraulic Servo Controlled Test Machines

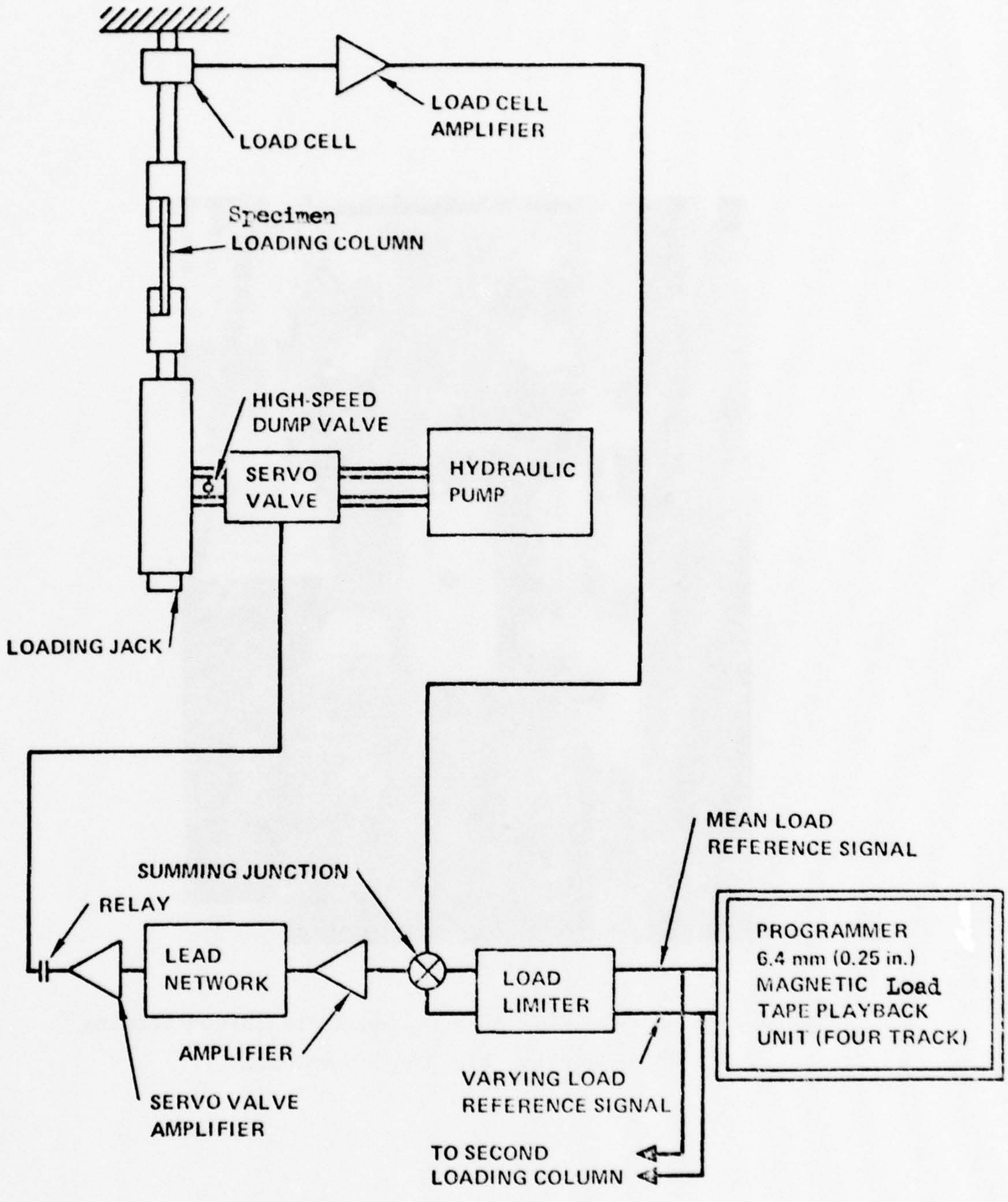


Figure 12 Block Diagram of Test Setup for Flight-by-Flight Spectra Fatigue Tests

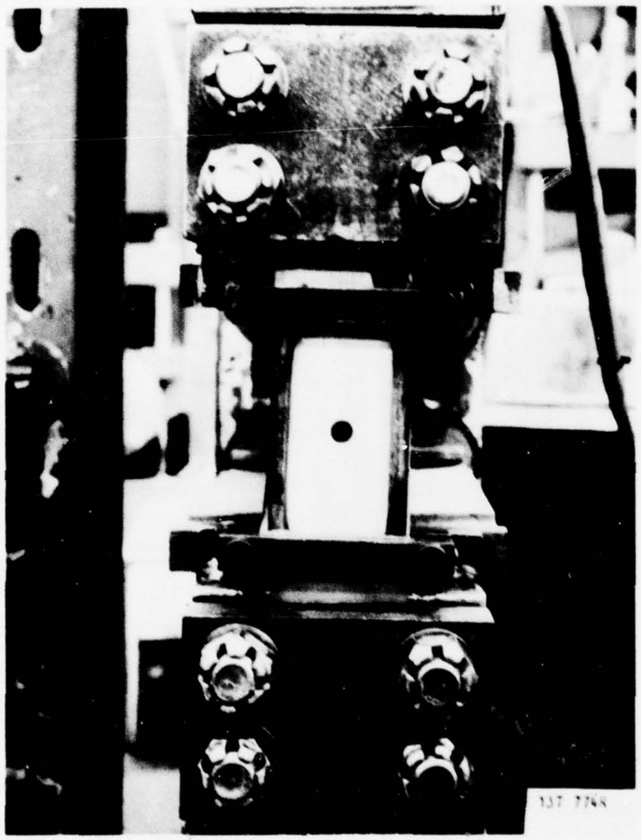


Figure 13 Close-up View of Specimen Installation Showing
Anti-Buckling Bar Support Assembly

During the testing, the specimens were examined at least every 1000 flights using a magnifying glass to detect incipient cracking. During the period of crack growth, a finely graduated ruler was read by a magnifying glass at intervals which were dependent upon the rate of crack growth.

The spectra of fatigue loadings used in this testing were derived from operational service loading records for the P-3A Fleet as a part of Contract N00019-76-A-001, Order No. KZ34, "Service Life Extension Program (SLEP) Part I", (Reference 1), which was performed at the Lockheed-California Company. This spectra is appropriate for use in this program, as it is basically the spectra to which the 7050-T7E73 material would be subjected if used in the P-3 series aircraft. Table 2 lists the gross area stress loads of the P-3A test spectra taken from Reference 1.

To preclude the fatigue test specimens being subjected to very large numbers of flights in the testing, the test spectra loadings were increased in magnitude by 15 to 30 percent to shorten the flights to crack initiation. In the tables and plots of the test data, this increase is noted as a stress factor (S.F.), by which all loadings in the spectra have been multiplied. For example, S.F. = 1.30 means all loadings have been multiplied by 1.30 (increased by 30 percent).

Specimens were generally selected for testing in pairs, one each of 7075-T6510 and 7050-T7E510 with the same stress concentration, processing, product form and grain direction. This procedure was adopted to minimize the effects of load variability. Additionally, each alloy pair was positioned in the test fixture to minimize any biasing effect due to position in the fixture.

All of the flight-by-flight spectra fatigue tests were conducted in laboratory ambient conditions at room temperature (R.T.) and 40 ±10% relative humidity (R.H.).

TABLE 2 FLIGHT-BY-FLIGHT FATIGUE TEST UPPER SURFACE STRESS SPECTRA
(P-3A OPERATIONAL MISSION MIX: SLEP, PART I)
(GROSS AREA STRESSES)

MEAN STRESS (KSI)	± CYCLIC STRESS (KSI)	MAXIMUM STRESS (KSI)	MINIMUM STRESS (KSI)	NORMALIZED STRESSES MEAN / 21.2	NORMALIZED STRESSES ± CYCLIC / 21.2	CYCLES* APPLIED IN 4000 FLTS.
TAXI AND LANDING						
3.8	4	7.8	- 0.2	0.179	0.189	17,500
	5	8.8	- 1.2		0.236	14,000
	6	9.8	- 2.2		0.283	4,400
	7	10.8	- 3.2		0.330	1,100
	8	11.8	- 4.2		0.377	340
	9	12.8	- 5.2		0.425	100
	10	13.8	- 6.2		0.472	38
	11	14.8	- 7.2		0.519	13
	12	15.6	- 8.2		0.566	5
3.8	13	16.8	- 9.2	0.179	0.613	4
MANEUVERS AND GUST						
-7.2	4	- 3.2	-11.2	-0.340	0.189	17,500
	5	- 2.2	-12.2		0.236	3,500
	6	- 1.2	-13.2		0.283	930
	7	- 0.2	-14.2		0.330	330
	8	+ 0.8	-15.2		0.377	130
	9	1.8	-16.2		0.425	65
	10	2.8	-17.2		0.472	24
	11	3.8	-18.2		0.519	10
	12	4.8	-19.2		0.566	6
	13	5.8	-20.2		0.613	4
-7.2	14	6.8	-21.2	-0.340	0.660	4

NOTE: * 1000 flight random cycle tape made which is applied four times to get the specified number of cycles in this column in 4000 flights containing an average of about 15 cycles per flight.

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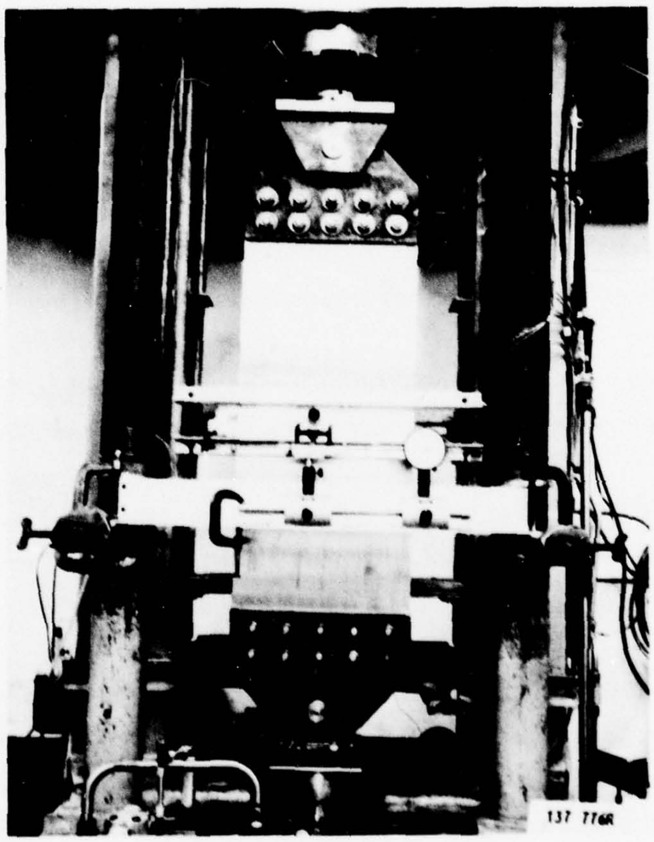

Figure 14 Crack Propagation Test Set-Up of
16 Inch Wide Specimen

Constant Amplitude Crack Propagation Tests. The crack propagation data were generated on closed-loop electro-hydraulic test machines at a loading frequency of 6 Hz. and a stress ratio of R = +0.10. Ambient air at ≈40% relative humidity (R.H.) and moist air at ≈98% R.H. environments were used at room temperature (R.T.).

To prevent out-of-loading-plane distortion of the test specimen in the vicinity of the crack, anti-buckling bars were attached approximately two inches above and below the crack as shown in Figs. 14 and 15.

Crack length readings were taken using optical techniques. Fig. 15 shows the 75 X10 micrometer microscope that was used.

Various gross stress levels were used to propagate cracking from the 2.0 inches long manufactured notch to crack lengths of 5.3 and 5.6 inches.

Fracture Toughness Tests. All fracture toughness (R-Curve) test procedures followed ASTM E 561-76T, entitled, "Tentative Recommended Practice for R-Curve Determination."

The fatigue precracking was conducted at 6 Hz in closed-loop electrohydraulic universal machines in laboratory air and at a stress ratio = +0.1. The maximum load was decreased so that a final value of ΔK of less than 20 ksi$\sqrt{in.}$ was maintained for the last 0.5 inch of crack growth to assure that a flat initial crack was developed for the fracture test.

All static fracture tests were conducted in laboratory air at room temperature or -65°F in a closed-loop electrohydraulic universal test machine. A loading rate of approximately 50,000 pounds/minute was used. Antibuckling guides were located approximately one inch above and below the plane of the crack in all tests. Two displacement gages were used to measure crack opening displacement, one on each side of the specimen. The gages used were the clip-on double cantilever type described in ASTM E 399, entitled "Standard Test Method

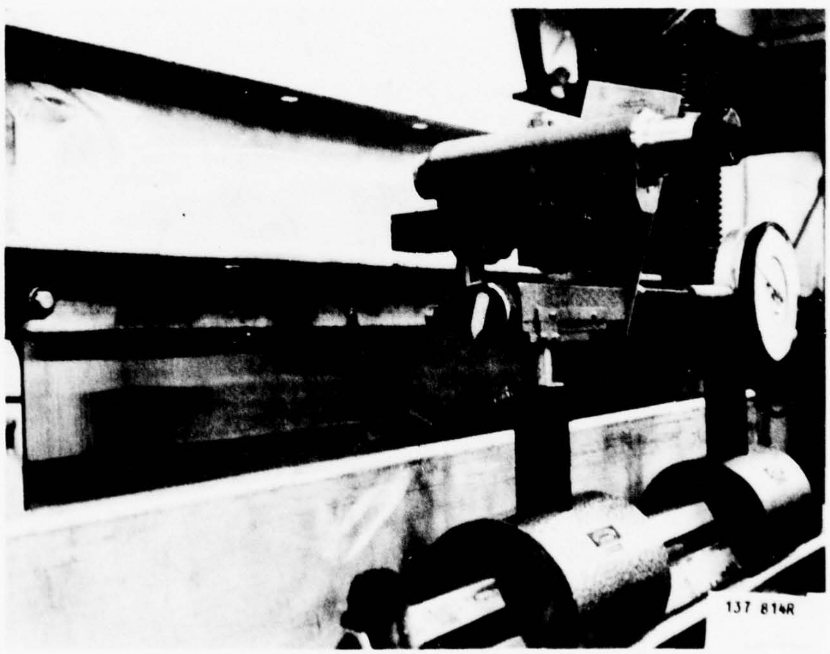

Figure 15 Close-Up View of Test Set-Up Showing
Anti-Buckling Bars and Microscope

for Plane-Strain Fracture Toughness of Metallic Materials." These gages were placed at the center of the crack between two gage mount blocks which were bonded to the specimen. The gage length was 0.20 inch. The outputs of the load transducer and the two compliance gages were fed directly into the Rye Canyon computer facility and computer-plotted results of load versus compliance were obtained. This test system has been described in detail in Reference 2 .

Average displacement measurements obtained from these two gages were used to determine the corresponding crack lengths. The translation from crack opening displacement (COD) to crack lengths was accomplished using the Liebowitz width corrected Irwin-Westergaard expression:

$$\frac{E\,(COD)}{SW} = \left[\frac{\pi c}{W} \Big/ \sin\left(\frac{\pi c}{W}\right)\right]^{\frac{1}{2}} \left\{\frac{2Y}{W}\left[\frac{2W}{\pi Y}\cosh^{-1}\left(\frac{\cosh\frac{\pi Y}{W}}{\cos\frac{\pi c}{W}}\right) - \frac{1+\mu}{\left[1+\left(\frac{\sin\frac{\pi c}{W}}{\sinh\frac{\pi Y}{W}}\right)^2\right]^{\frac{1}{2}}} + \mu\right]\right\}$$

Where:

E = modulus of elasticity

μ = Poisson's Ratio

COD = $2v$ = crack opening displacement

c = 1/2 total effective crack length

S = gross stress

W = test panel width

Y = 1/2 span of COD gage

The equipment used for the room temperature tests was also used for the tests conducted at -65°F. The center crack area on the panel was enclosed and nitrogen gas from a liquid nitrogen tank was metered into the enclosed chamber under closely controlled and continuously monitored conditions,

utilizing monitoring and controlling thermocouples attached to the panel, and solenoid actuated valves. The temperature was stabilized at -65 ± 5°F across the panel width for 5 minutes prior to testing. Figure 16 shows a -65°F test set-up.

Data reduction was conducted per ASTM E561-76T.

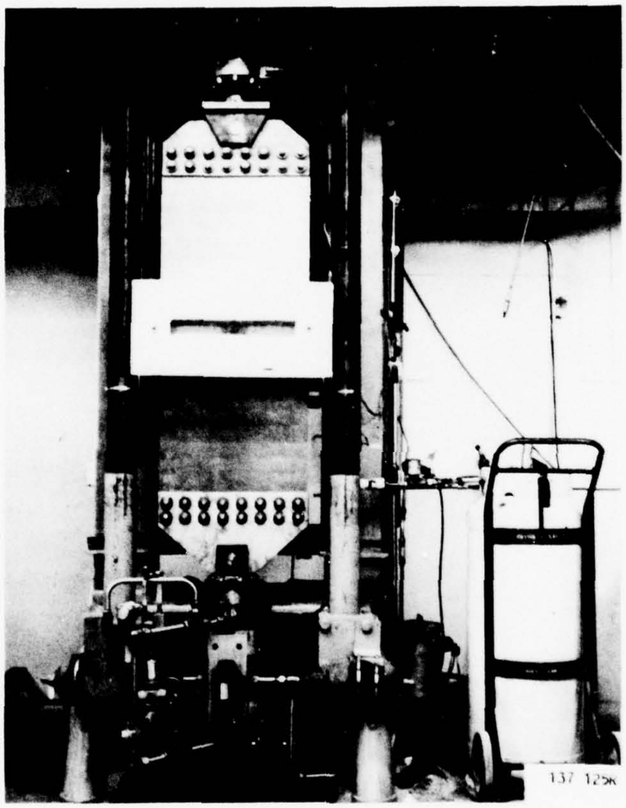

Figure 16 Typical Test Set-Up of -65°F Fracture Toughness Specimen Showing Chamber in Position

V. TEST RESULTS AND DISCUSSION

Chemical Analyses. The chemical analyses results, Table 3 , show all the test material was within the required chemical composition limits. The analyses performed on the 7050-T7E73 wing plank material at Lockheed and Alcoa's Technical Center were in close agreement.

Tensile Properties. The tensile results, Tables 4 through 6, show the 7050-T7E73 and 7075-T6510 test material have comparable tensile properties. All the 7050 test values show a 5 percent or greater margin over the 7075-T6 extrusion specification minimum properties. Specifically, the longitudinal 7050-T7E73 properties exceed the 7075-T6 minimum requirements by 4 to 11 Ksi in tensile strength, 5 to 11 Ksi in yield strength and 3 to 7 percent in elongation.

Associated with tensile properties, corresponding Rockwell B hardness values were determined on the test material and reported in Tables 4 through 6.

Exfoliation Behavior. The exfoliation test results, Tables 4 through 6, show the 7050-T7E73 extrusions to have an acceptable level of exfoliation corrosion resistance and the 7075-T6510 extrusion to be almost as good. The behavior of the 7075 material in this test program is better than expected for the T6 condition. The Lockheed results represent a composite of the EXCO and 7 day salt spray test results. Some difficulty was encountered with EXCO testing in that one set of results showed the 7050-T7E73 wing planks to have an ED rating on the T/10 planes and upon retesting adjacent specimens only pitting was observed. The 7 day salt spray results were more consistent and less severe than the EXCO tests in that the 7050 wing planks had an EA rating on the T/10 plane. The results from Alcoa's Technical Center are the result of EXCO testing and are in agreement with the Lockheed composite rating.

TABLE 3 CHEMICAL COMPOSITIONS OF 7050-T7E73 AND 7075-T6510 TEST MATERIALS

ALLOY	SHAPE	DATA SOURCE	Zn	Mg	Cu	Fe	Si	Mn	Cr	Zr	Ti	OTHER
7050	All	Spec(1) Limits	5.7-6.7	1.9-2.6	2.0-2.6	0.15	0.12	0.10	0.04	.08-.15	0.06	0.05
	Spar	LAC	5.76	2.19	2.00	0.10	0.07	0.004	0	0.09	0.04	.001 Be
	Plank Lot A	LAC	6.48	2.36	2.01	0.082	0.06	0	0	0.09	0.05	.002 Be
		Alcoa Tech. Center	6.35	2.43	2.08	0.08	0.05	0	0.01	0.10	0.042	--
	Plank Lot B	LAC	6.58	2.38	2.03	0.085	0.07	0	0	0.10	0.05	.001 Be
		Alcoa Tech. Center	6.67	2.48	2.09	0.09	0.07	0	0	0.10	0.042	--
7075	All	Spec(1) Limits	5.1-6.1	2.1-2.9	1.2-1.9	0.35	0.25	0.30	0.18-0.35	0	0.20	0.05
	Spar	LAC	5.50	2.51	1.54	0.17	0.11	0.02	0.19	0	0.04	.002 Be
	Plank	LAC	5.13	2.45	1.34	0.17	0.10	0.01	0.23	0	0.04	--

(1) Maximum limits unless a range is specified

TABLE 4 PROPERTIES OF 7050-T7E73 AND 7075-T6510 P-3 WING SPAR CAP EXTRUSIONS

ALLOY	DATA SOURCE	GRAIN DIRECT.	ELECT. COND.(1) % IACS	EXFOL RATING(2)	ROCKWELL HARDNESS HRB	TENSILE PROPERTIES TENSILE Ksi	YIELD Ksi	ELONG. % in 1"
7050	LAC	L		S/P		91.2	85.4	12.0
		L				92.3	86.0	12.0
		LT	37.0	T/10 / EA	91.0	85.7	79.0	12.0
		LT	37.5			86.2	79.4	11.0
		ST		T/2 / EA		86.8	79.9	12.0
		ST				86.5	79.5	14.0
	ALCOA Test Rept.	L max		--	--	91.1	85.7	14.5
		L min	36.7			86.3	80.3	13.0
7075	LAC	L		S/P		92.3	84.3	10.0
		L				95.4	88.4	10.0
		LT	30.8	T/10 / P	90.5	85.8	76.9	13.0
		LT	33.0			84.6	75.8	10.0
		ST		T/2 / EC		86.6	77.3	12.0
		ST				87.3	77.6	12.0
	Typical Alcoa Test Rept.	L max	--	--	--	91.9	84.9	12.0
		L min				91.1	83.9	12.0
		LT max				86.0	77.4	12.0
		LT min				85.3	77.4	12.0
	LAC-04-551 (QQ-A-200/11)	L	--	--	--	81	72	7
		LT	--	--	--	73	63	4

(1) % International Annealed Copper Standard

(2) Plane Evaluated / Exfol Rating: S = Surface, T/10 = 1/10 plane, T/2 = mid plane; Rating per ASTM G34

TABLE 5 PROPERTIES OF 7050-T7E73 P-3 WING PLANK EXTRUSIONS

ALLOY	DATA SOURCE	GRAIN DIRECT	ELECT. COND. % IACS(1)	EXFOL RATING(2)	ROCKWELL HARDNESS HRB	TENSILE PROPERTIES TENSILE Ksi	YIELD Ksi	ELONG. % in 1"
7050 Lot A (H32482A1)	LAC	L		$\frac{S}{P}$		87.2	78.6	14.0
		L				86.8	77.9	13.0
		LT	38.3	$\frac{T/10}{EA}$	88.0	85.2	76.4	14.0
		LT	39.0			85.6	77.0	13.0
		ST		$\frac{T/2}{EB}$		82.9	72.5	7.0(3)
		ST				82.3	72.1	8.0(3)
	Alcoa Test Rept	L max	38.6	--	--	86.1	77.7	14.5
		L min	38.9	--	--	85.6	76.5	14.5
	Alcoa Tech. Center	L				86.1	78.1	13.6
		L		$\frac{T/10}{EA}$		85.2	77.4	14.3
		L	38.7		--	85.7	78.4	13.6
		LT	39.1	$\frac{T/2}{EB}$		83.7	76.3	13.6
		LT				83.9	76.1	14.3
		LT				83.0	75.3	12.1
7050 Lot B (H32483A1)	LAC	L		$\frac{S}{P}$		87.1	79.7	13.0
		L				86.5	78.8	13.0
		LT	38.3	$\frac{T/10}{EA}$	88.5	85.1	76.7	12.0
		LT	39.0			85.5	77.0	12.0
		ST		$\frac{T/2}{EB}$		82.3	72.5	7.0(3)
		ST				81.9	73.1	4.0(3)
	Alcoa Test Rept	L max	38.6	--	--	86.7	78.0	14.0
		L min	38.9	--	--	84.9	76.5	13.0
	Alcoa Tech. Center	L				85.1	77.3	13.6
		L		$\frac{T/10}{EA}$		84.9	77.0	13.6
		L	38.5			85.2	77.4	14.3
		LT	38.9	$\frac{T/2}{EB}$	--	84.1	76.0	14.3
		LT				83.4	75.8	12.8
		LT				83.4	75.2	11.4

(1) % International Annealed Copper Standard

(2) $\frac{\text{Plane Evaluated}}{\text{Exfol Rating}}$ S = Surface, T/10 = 1/10 plane, T/2 = mid plane
Rating per ASTM G34

(3) % Elongation in .5 inch

TABLE 6 PROPERTIES OF 7075-T6510 P-3 WING PLANK EXTRUSIONS

ALLOY	DATA SOURCE	GRAIN DIRECT	ELECT. COND. % IACS(1)	EXFOL RATING(2)	ROCKWELL HARDNESS HRB	TENSILE PROPERTIES TENSILE Ksi	YIELD Ksi	ELONG. % in 1"
7075	LAC	L		S/P		87.5	77.0	9.0
		L				90.1	80.4	9.0
		LT	32.5	T/10 / EA	89.0	88.4	76.9	12.0
		LT	34.3			87.3	76.4	10.0
		ST		T/2 / EC		83.3	73.6	5.0(3)
		ST				85.0	74.0	5.0(3)
	Typical Alcoa Test Rept	L max	--	--	--	89.8	82.0	12.5
		L min				88.3	80.8	12.0
	LAC-04-622 (QQ-A-200/11)	L	--	--	--	81	72	7

(1) % International Annealed Copper Standard

(2) Plane Evaluated / Exfol Rating   S = Surface, T/10 = 1/10 plane, T/2 = mid plane
Rating per ASTM G34

(3) % Elongation in .5 inch

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CALIFORNIA COMPANY

In addition to exfoliation testing, the electrical conductivities of the test materials were measured, since conductivity is used to confirm proper age stabilization for acceptable corrosion resistance. The values, shown as percent International Annealed Copper Standard (% IACS) are presented in Tables 4 through 6. The 7050-T7E73 material had electrical conductivity values of 37.0 to 39.1% IACS and the 7075-T6510 material had values of 30.8 to 34.3% IACS.

Stress Corrosion Resistance. Although stress corrosion testing was not included as part of the Lockheed testing, stress corrosion testing was performed at Alcoa's Technical Center in accordance with ASTM G44-75 entitled "Standard Recommended Practice for Alternate Immersion Stress Corrosion Testing in 3.5% Sodium Chloride Solution." The results, in Appendix A, showed 0.75 inch "C" rings taken in the short transverse grain direction of 7050-T7E73 wing planks and stressed to 10, 15, 20, and 25 Ksi had no failure after 47 days of testing. Tensile specimens, 0.125 inch diameter, taken in the longitudinal grain direction and stress to 20 and 35 Ksi had no failure after 47 days of testing.

Flight-by-Flight Spectra Fatigue. Cross references of test specimen identifications, conditions and test data for the spectra fatigue specimens are shown in Table 7. The flight-by-flight spectra fatigue test results are shown in Figs. 17 through 26. In these figures, cracking which occurs on both sides of the stress concentration is added to the hole diameters (.250 inch for K_t = 2.7 and .300 inch for K_t = 4.0, Ref. Figs. 6 and 7) and the total lengths are plotted vs. flight hours. The average number of flight hours per flight for this service mission mix is five.

Basically, the flight-by-flight fatigue test data show that fatigue lives of 7050-T7E73 are as good or better than 7075-T6510 for small crack lengths of approximately .15 inches, for the products and conditions tested in this program. This is shown in Figs. 17 through 26, and compared in Table 8.

TABLE 7 SPECTRA FATIGUE TEST SPECIMENS

MATERIAL	PROCESSING	SHAPE	GRAIN DIRECTION	STRESS CONC.	NO. OF SPECIMENS	SPECIMEN IDENTIFICATION	CRACK GROWTH CURVES, FIG.
7050-T7E73	Machine, Etch and Chem. Film	Spar Cap	L	2.7	2	5M21, 5M22	17
		Plank, Lot A	L	2.7	2	LA1, LA2	18
		Plank, Lot B	L	2.7	2	LB1, LB2	18
	Machine, Shot Peen, Etch and Chem. Film	Spar Cap	L	2.7	2	5S21, 5S22	19
		Plank, Lot A	L	2.7	2	LA3, LA4	20
		Plank, Lot B	L	2.7	2	LB3, LB4	20
7075-T6510	Machine, Etch and Chem. Film	Spar Cap	L	2.7	2	7M21, 7M22	17
		Plank	L	2.7	2	L1, L2	18
	Machine, Shot Peen, Etch and Chem. Film	Spar Cap	L	2.7	2	7S21, 7S22	19
		Plank	L	2.7	2	L3, L4	20
7050-T7E73	Machine, Etch and Chem. Film	Spar Cap	L	4.0	2	5M41, 5M42	21
		Plank, Lot A	L	4.0	2	LA5, LA6	22
		Plank, Lot A	LT	4.0	2	LTA1, LTA2	23
		Plank, Lot B	L	4.0	2	LB5, LB6	22
		Plank, Lot B	LT	4.0	2	LTB1, LTB2	23
	Machine, Shot Peen, Etch and Chem Film	Spar Cap	L	4.0	2	5S41, 5S42	24
		Plank, Lot A	L	4.0	2	LA7, LA8	25
		Plank, Lot A	LT	4.0	2	LTA3, LTA4	26
		Plank, Lot B	L	4.0	2	LB7, LB8	25
		Plank, Lot B	LT	4.0	2	LTB3, LTB4	26
7075-T6510	Machine, Etch and Chem. Film	Spar Cap	L	4.0	2	7M41, 7M42	21
		Plank	L	4.0	2	L5, L6	22
		Plank	LT	4.0	2	LT1, LT2	23
	Machine, Shot Peen, Etch and Chem. Film	Spar Cap	L	4.0	2	7S41, 7S42	24
		Plank	L	4.0	2	L7, L8	25
		Plank	LT	4.0	2	LT3, LT4	26

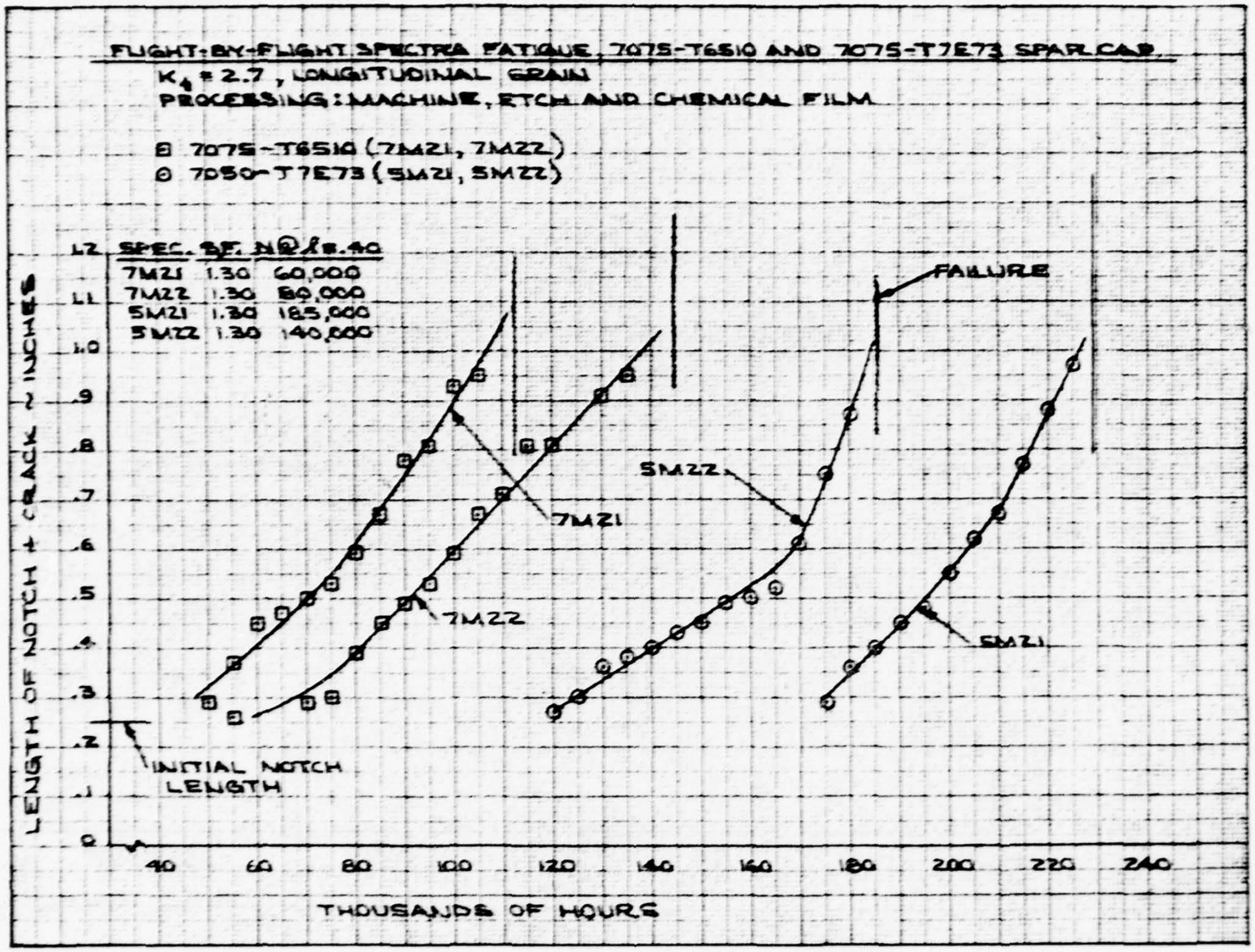

Figure 17 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Spar Cap Specimens, K_t=2.7, Machine, Etch and Chemical Film Processing

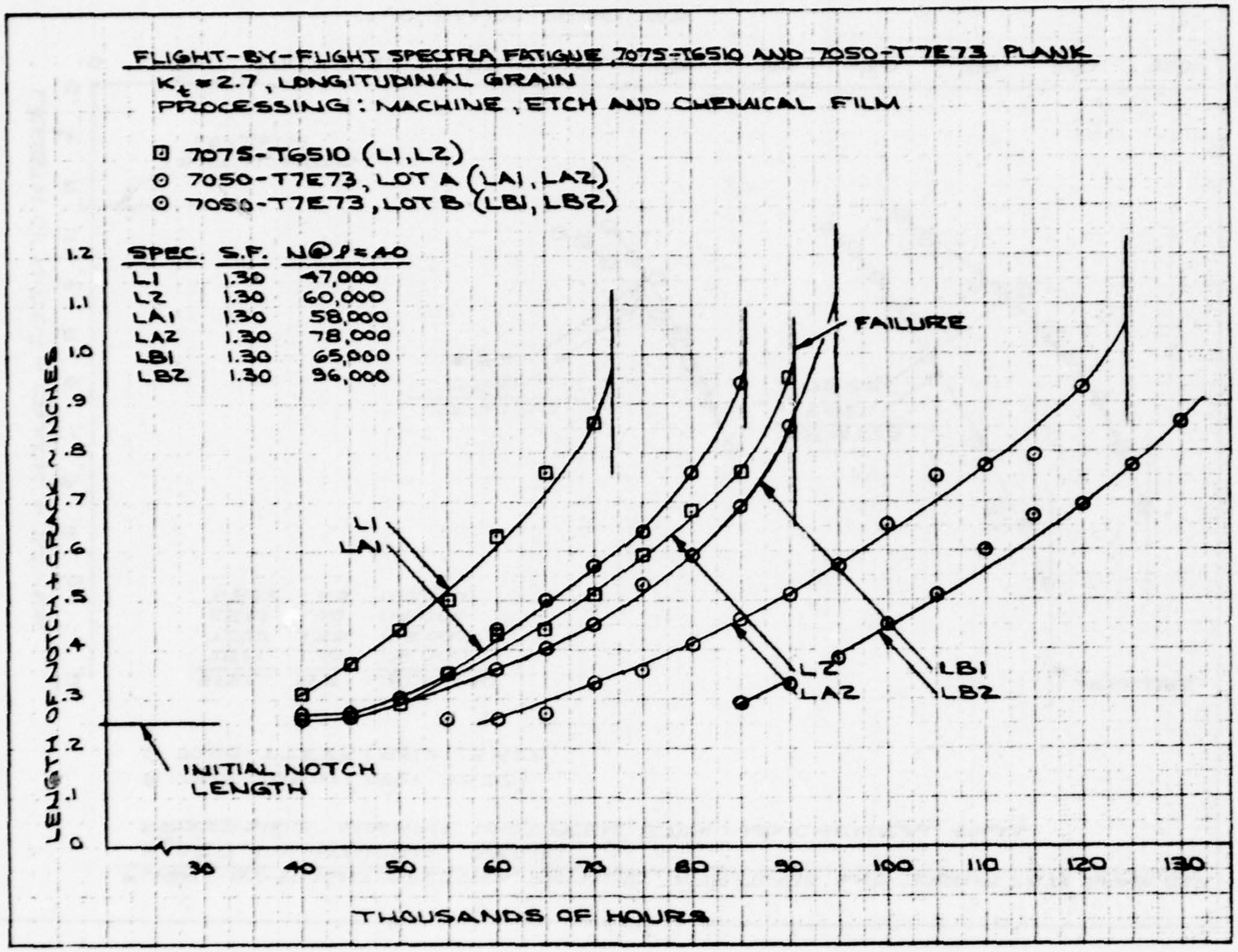

Figure 18 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Wing Plank Specimens, K_t=2.7, Machine, Etch and Chemical Film Processing

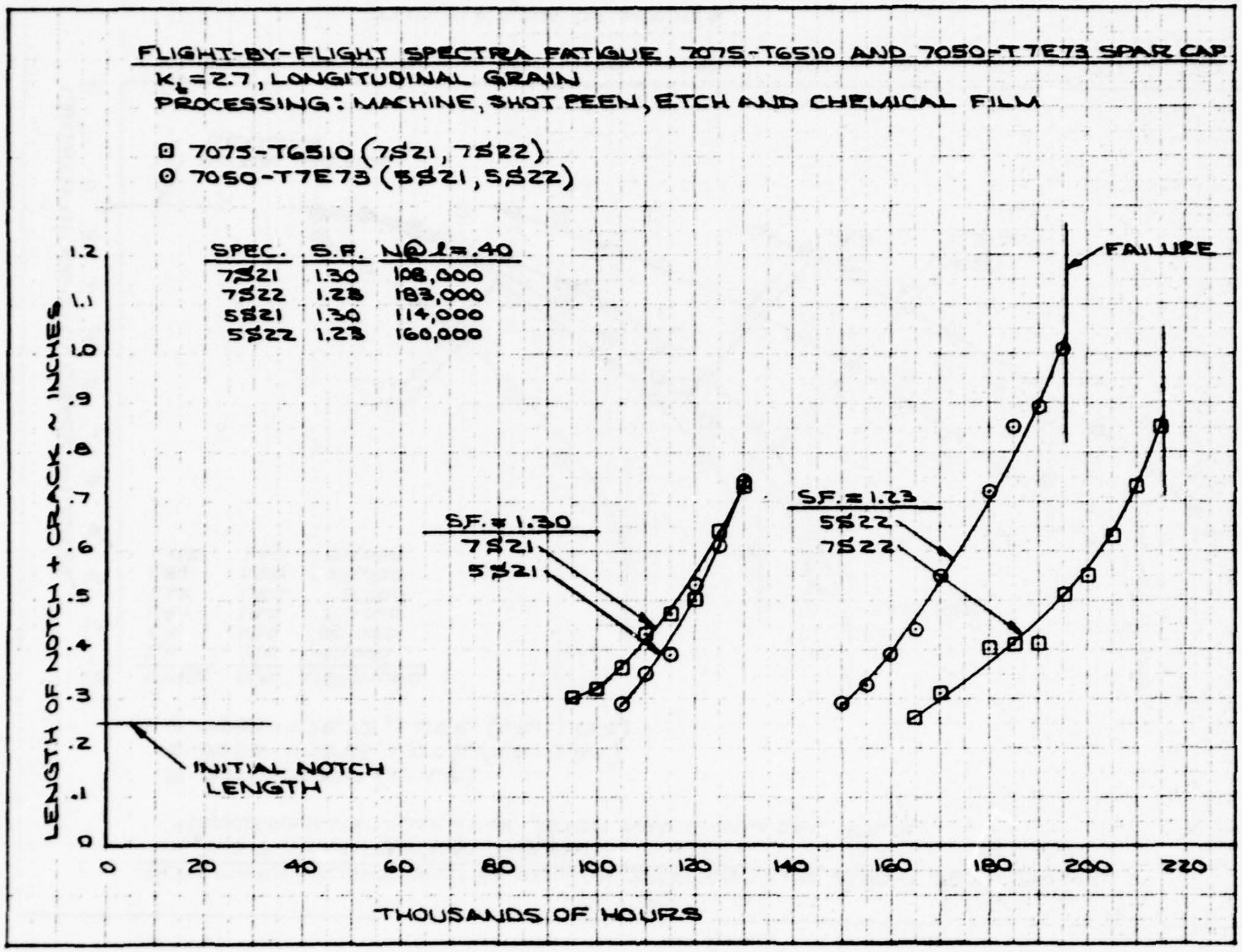

Figure 19 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Spar Cap Specimens, K_t=2.7, Machine, Shot Peen, Etch and Chemical Film Processing

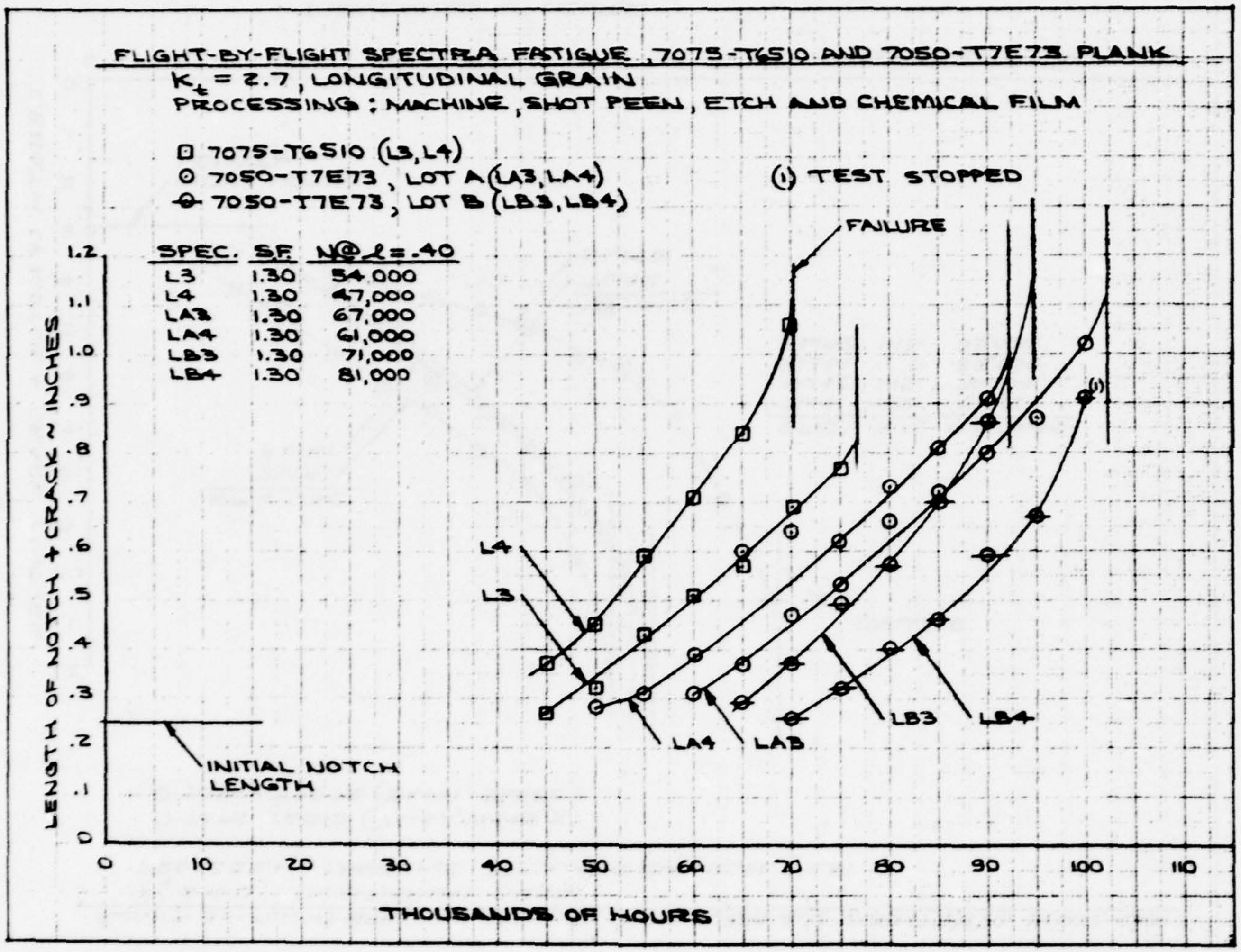

Figure 20 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Wing Plank Specimens, K_t=2.7, Machine, Shot Peen, Etch and Chemical Film Processing

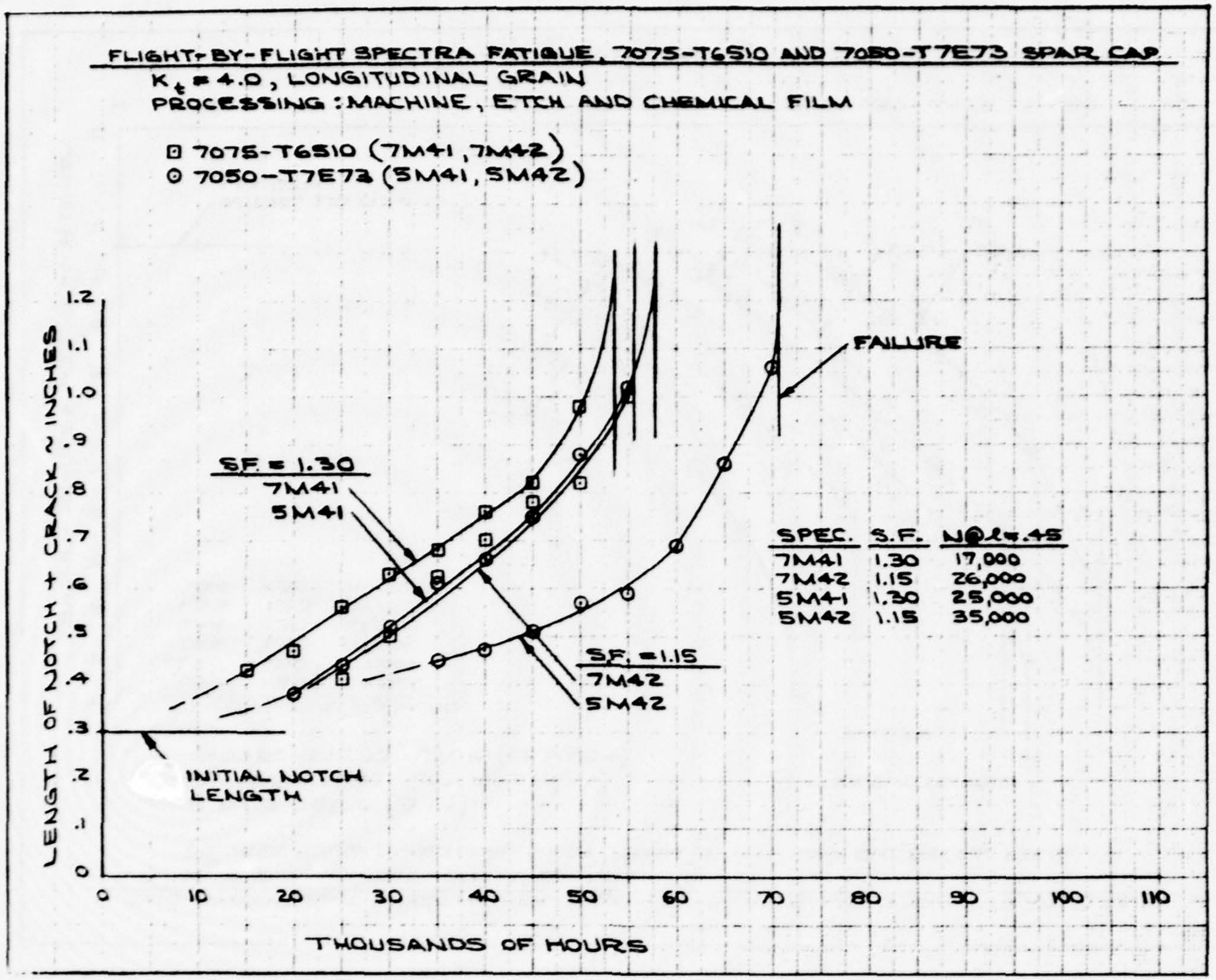

Figure 21 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Spar Cap Specimens, K_t=4.0, Machine, Etch and Chemical Film Processing

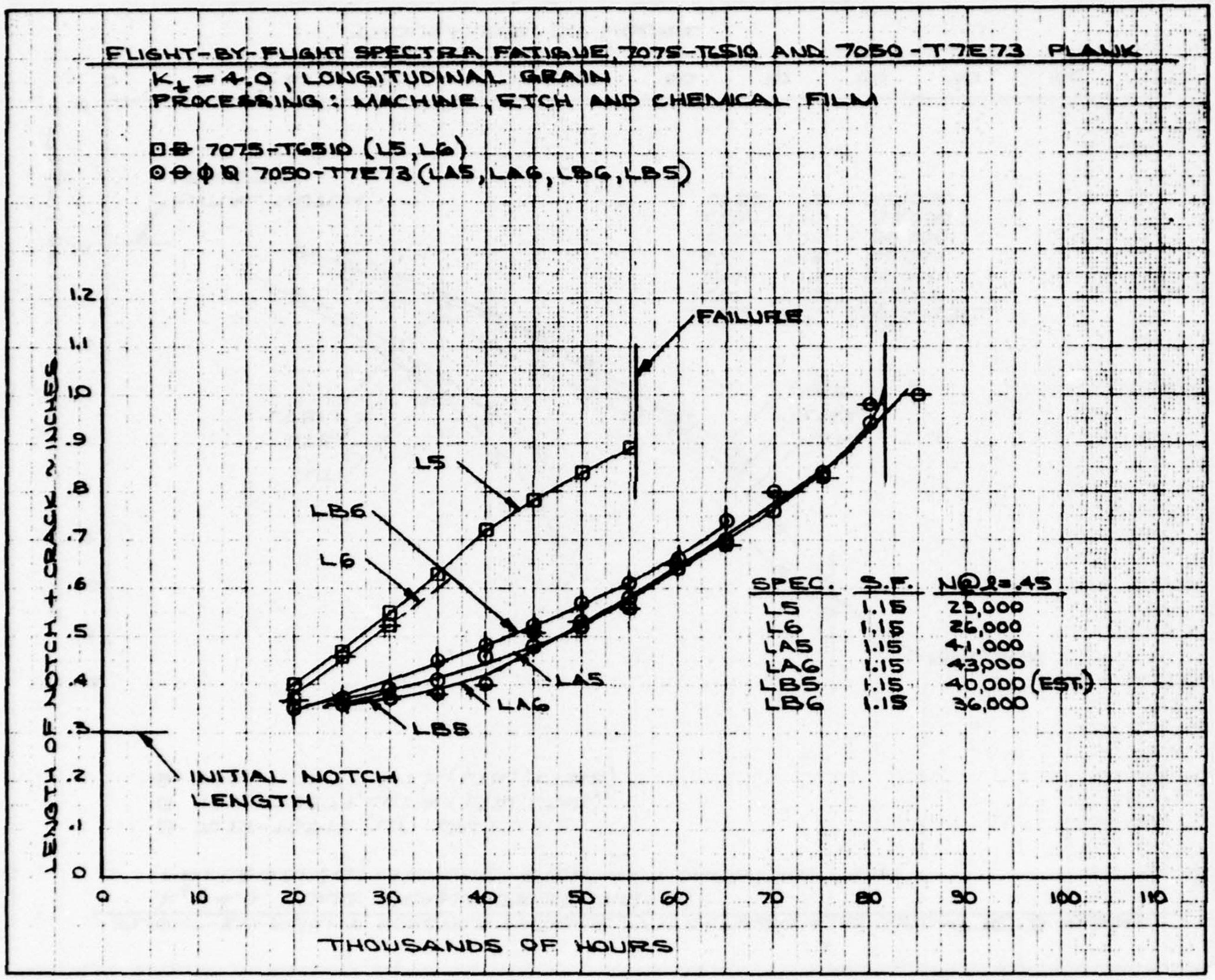

Figure 22 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Wing Plank Specimens, K_t=4.0, Machine, Etch and Chemical Film Processing

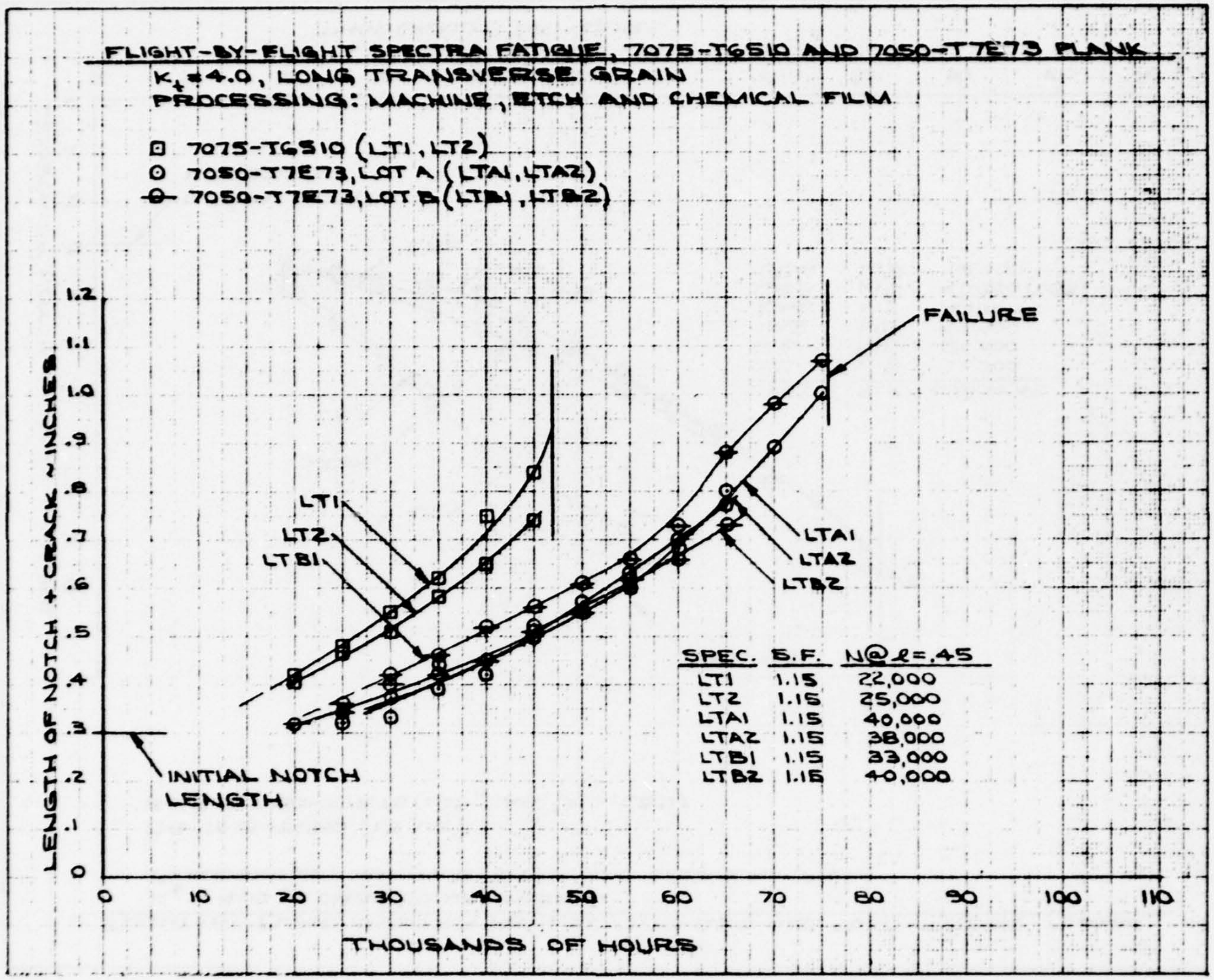

Figure 23 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Wing Plank Specimens, $K_t = 4.0$, Machine, Etch and Chemical Film Processing

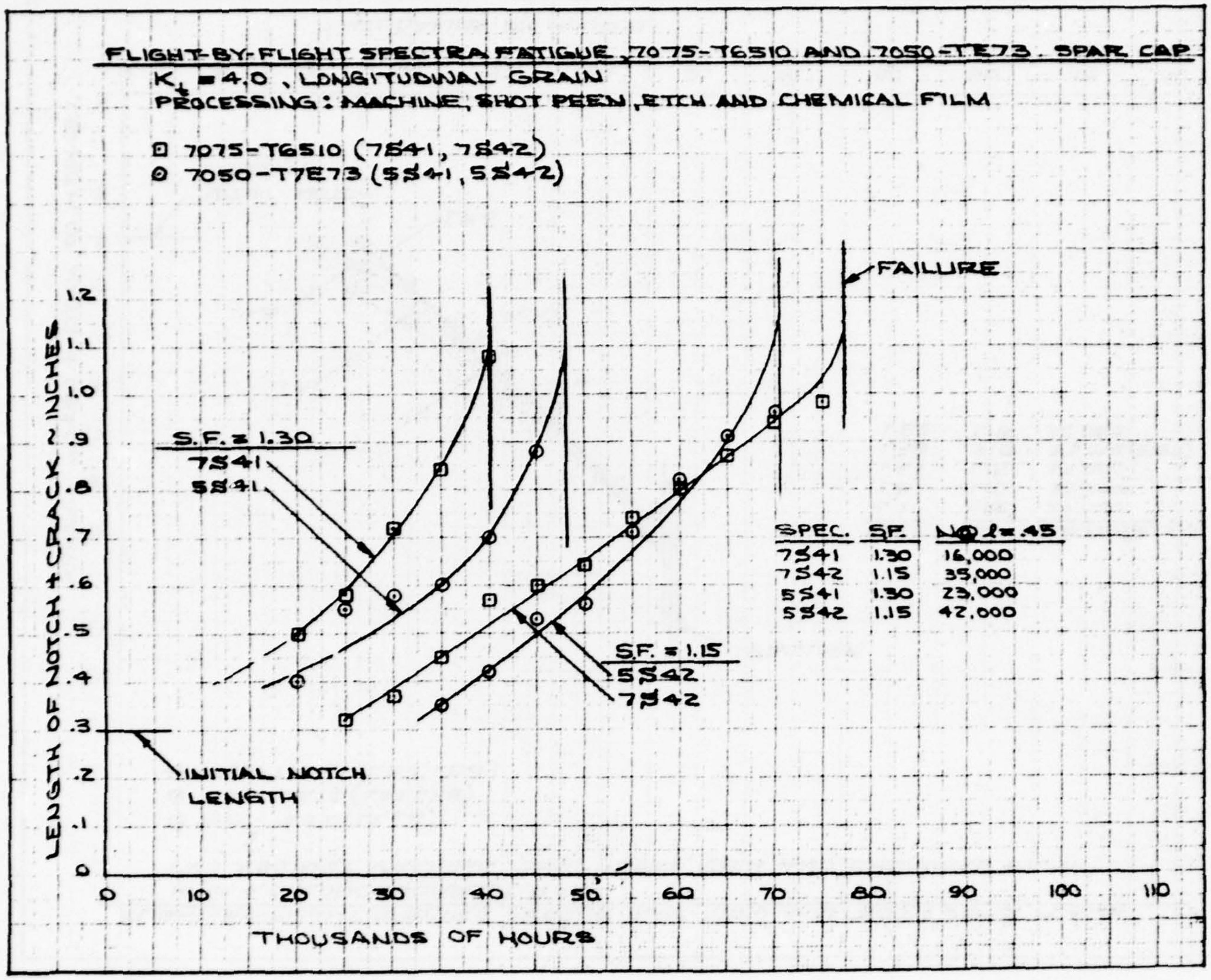

Figure 24 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Spar Cap Specimens, K_t = 4.0, Machine, Shot Peen, Etch and Chemical Film Processing

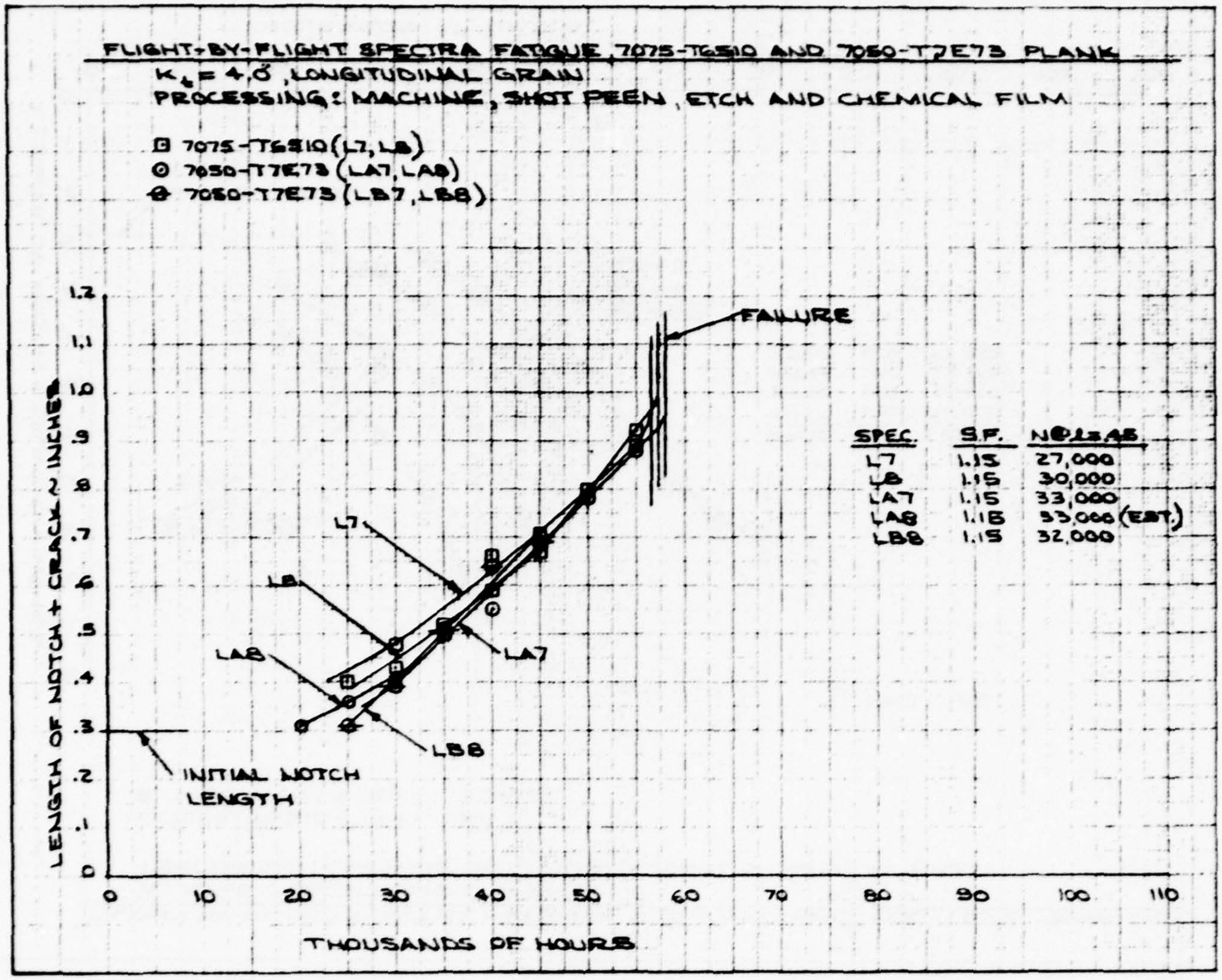

Figure 25 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Wing Plank Specimens, K_t = 4.0, Machine, Shot Peen, Etch and Chemical Film Processing

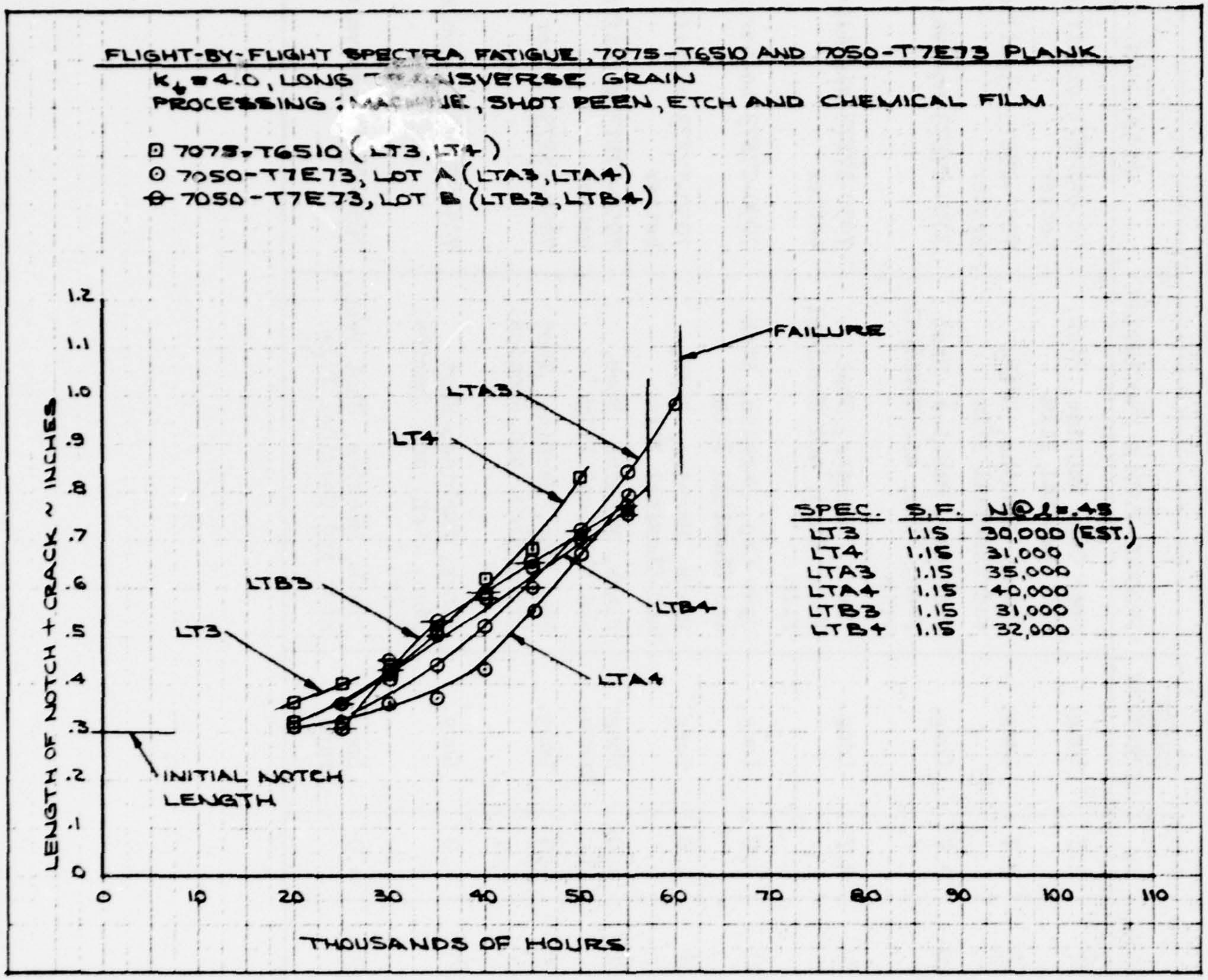

Figure 26 Fatigue Cracking of 7075-T6510 and 7050-T7E73 Wing Plank Specimens, K_t = 4.0, Machine, Shot Peen, Etch and Chemical Film Processing

TABLE 8 COMPARISON OF FATIGUE TEST RESULTS

FIGURE	K_t	GRAIN DIRECTION	PRODUCT FORM & PROCESSING	COMPARISON
17	2.7	Long.	Spar Cap, Machine, Etch, and Chemical Film	7050-T7E73 significantly better
18	2.7	Long.	Plank, Machine, Etch, and Chemical Film	7050-T7E73 significantly better
19	2.7	Long.	Spar Cap, Machine, Shot Peen, Etch, and Chemical Film	7050-T7E73 equivalent
20	2.7	Long.	Plank, Machine, Shot Peen, Etch, and Chemical Film	7050-T7E73 significantly better
21	4.0	Long.	Spar Cap, Machine, Etch and Chemical Film	7050-T7E73 better
22	4.0	Long.	Plank, Machine, Etch, and Chemical Film	7050-T7E73 significantly better
23	4.0	Long Trans.	Plank, Machine, Etch, and Chemical Film	7050-T7E73 significantly better
24	4.0	Long.	Spar Cap, Machine, Shot Peen, Etch, and Chemical Film	7050-T7E73 better
25	4.0	Long.	Plank, Machine, Shot Peen, Etch, and Chemical Film	7050-T7E73 equivalent
26	4.0	Long Trans.	Plank, Machine, Shot Peen, Etch and Chemical Film	7050-T7E73 equivalent

For spectra fatigue, magnitudes of all gross area stress levels in the loading spectra listed in Table 2 were increased by a fixed percentage to increase the severity of the spectra. This increase was effected to produce realistic test durations for the stress concentrations which were tested. The fixed percentage increases used in each test are expressed as a stress factor (S.F.) and are given in Figs. 17 through 26.

In examining Table 8, it is apparent that the fatigue improvement of 7050-T7E73 over the 7075-T6510 is more pronounced for the machine, etch and chemical film processing comdination than for the processing combination which includes shot peening.

The flight-by-flight spectra fatigue test results are presented in tabular form in Appendix B.

Crack Propagation. The test specimen identification and test conditions are shown in Table 9. The constant amplitude crack propagation data generated in this program were reduced to crack growth rate (da/dN) using a Lockheed computer program and plotted in Figures 27 and 28 as a function of $\Delta\bar{K}$. The selection of $\Delta\bar{K}$ was made to facilitate the comparison with other similarly derived data. The expression for $\Delta\bar{K}$ is:

$$\Delta\bar{K} = (1 - R)^{m} S_{max} \sqrt{\pi \text{ a SEC}\left(\frac{\pi a}{w}\right)}, \text{ where}$$

$\Delta\bar{K}$ is in units of ksi$\sqrt{\text{in}}$.

R = Stress Ratio (S_{min}/S_{max})

= .1 for this program

m = .5

S_{max} = Maximum gross area stress in ksi

a = 1/2 of the total crack length = 1/2 of the starter notch plus cracking on each side of notch

w = Width of panel.

TABLE 9 LIST OF CRACK PROPAGATION SPECIMENS(1) AND TEST CONDITIONS

MATERIAL(2)	PANEL NUMBER	FREQUENCY	ENVIRONMENT(3)	CRACK LENGTH, IN. INITIAL	FINAL
7050-T7E73 Lot A	1	6 Hz.	Lab Air	2.0	5.6
	2	6 Hz.	Humid Air	2.0	5.3
7050-T7E73 Lot B	4	6 Hz.	Lab Air	2.0	5.3
	5	6 Hz.	Humid Air	2.0	5.3
7075-T6510	7	6 Hz.	Lab Air	2.0	5.3
	8	6 Hz.	Lab Air	2.0	5.3
	9	6 Hz.	Humid Air	2.0	5.3
	10	6 Hz.	Humid Air	2.0	5.3

(1) Panel width = 16.1 inches; Panel thickness = .09 inches

(2) Longitudinal grain direction, wing plank extrusion

(3) Room Temperature
Lab air ≈40% relative humidity
Humid air ≈98% relative humidity

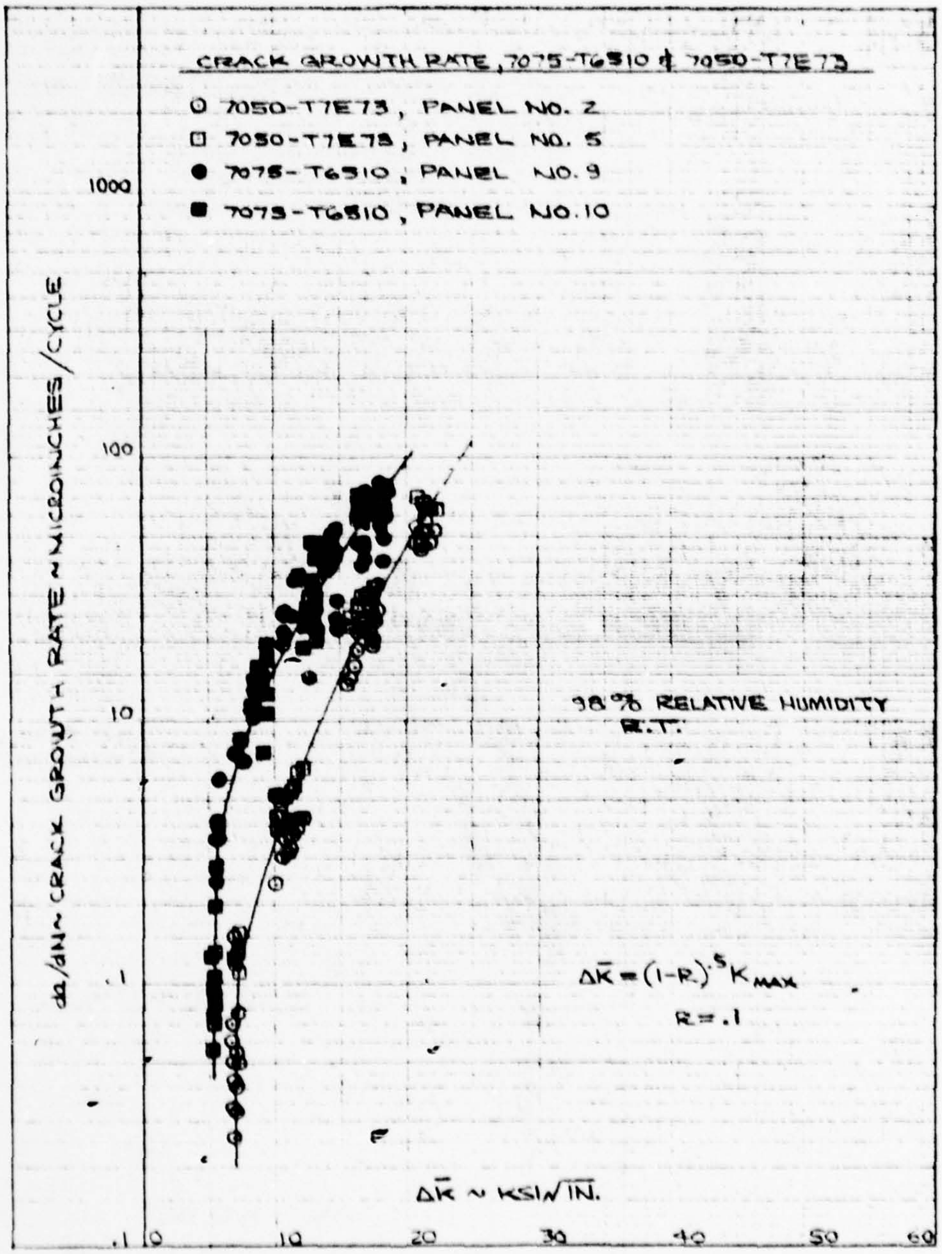

Figure 27 Crack Growth Rate vs $\Delta\bar{K}$, 7075-T6510 and 7050-T7E73 Wing Plank, 98% Relative Humidity

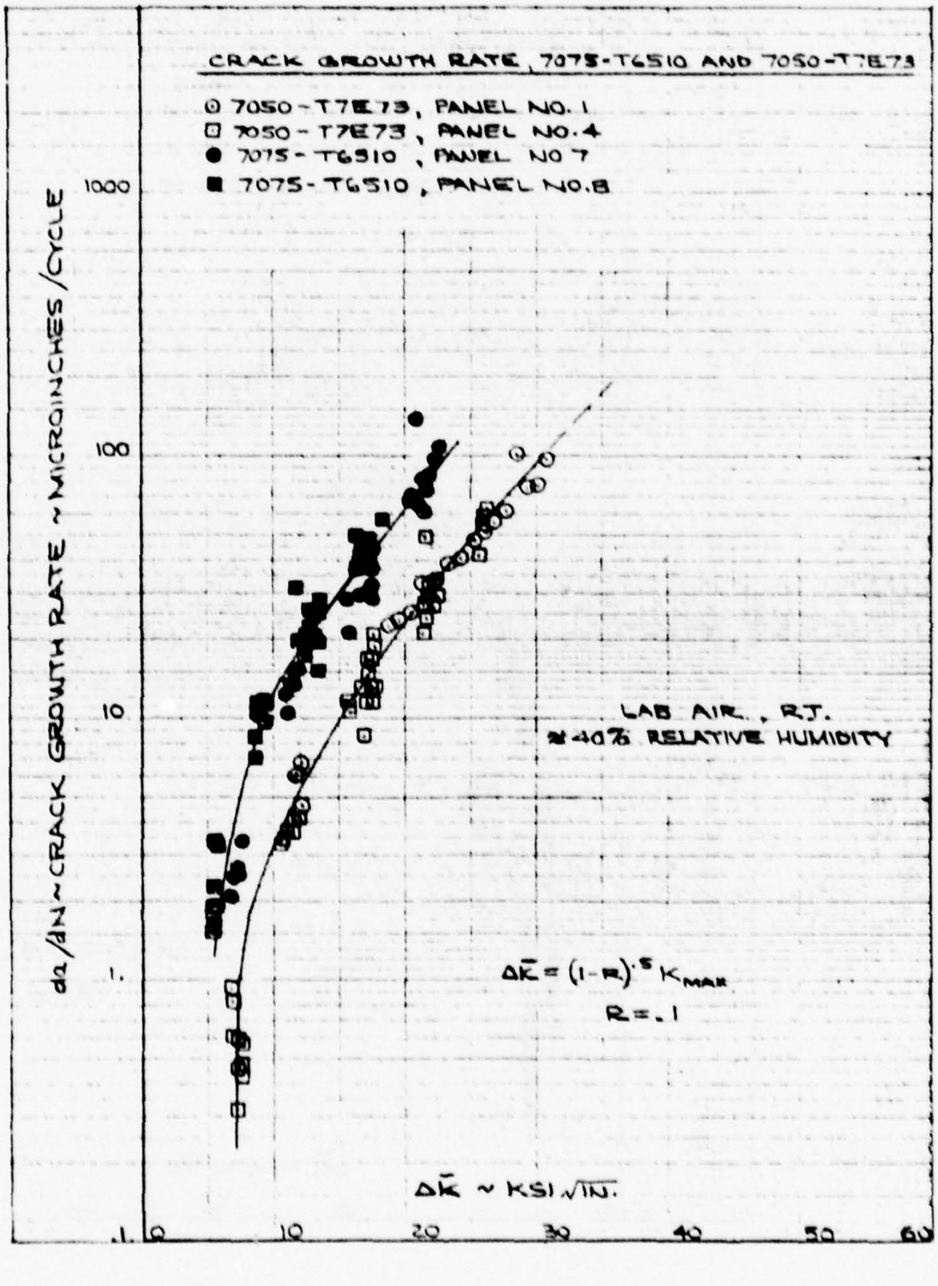

Figure 28 Crack Growth Rate vs $\Delta\overline{K}$, 7075-T6510 and 7050-T7E73 Wing Plank, 40% Relative Humidity

Figure 27 compares the crack growth rates for 7050-T7E73 and 7075-T6510 tested in a laboratory air environment. It shows that the crack propagation properties of the 7050-T7E73 are significantly better than those of the 7075-T6510, i.e., the indicated threshold $\Delta\bar{K}$ is approximately 30% higher for 7050-T7E73 and da/dN of 7050-T7E73 is approximately 33% of the 7075-T6510 values. Figure 28 discloses somewhat the same results, showing the 7050-T7E73 again significantly better in crack propagation properties in a 98% relative humidity environment.

The crack propagation data are presented in tabular form in Appendix C.

<u>Fracture Toughness.</u> The resistance-to-fracture curves (R - curves) are presented in Figs. 29 and 30 for room temperature and -65°F respectively. In Fig. 29, for the room temperature testing, an envelope has been drawn for each material to show the scatter bands. This illustrates that 7050-T7E73 has significantly higher fracture resistance than the 7075-T6510, with an increase of approximately 60 to 70 percent above the 7075-T6510 values. Similarly, the increase in fracture resistance for the 7050-T7E73 over the 7075-T6510 is of the order of 60 to 70 percent for a test temperature of -65°F, as shown in Figure 30.

Table 10 lists the test conditions and calculated values of $K_{apparent}$ and K_c. The formulations used were:

$$K_{apparent} = S_{max} \sqrt{\pi c_i \, SEC\left(\frac{\pi c_i}{w}\right)}$$

and

$$K_c = S_{max} \sqrt{\pi c_{cr} \, SEC\left(\frac{\pi c_{cr}}{w}\right)} \quad \text{where,}$$

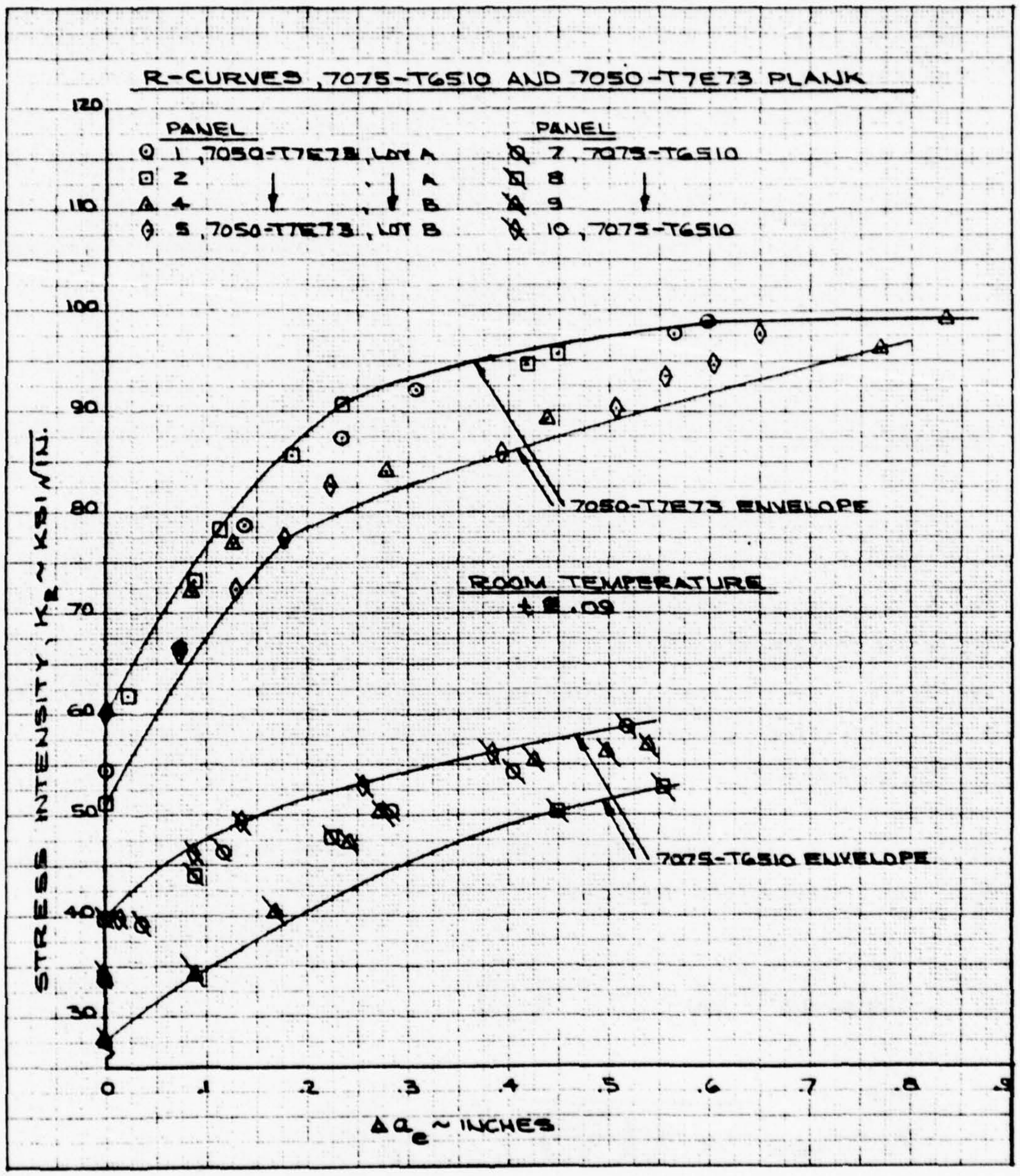

Figure 29 R-Curve Data For 7075-T6510 and 7050-T7E73 Wing Plank at Room Temperature

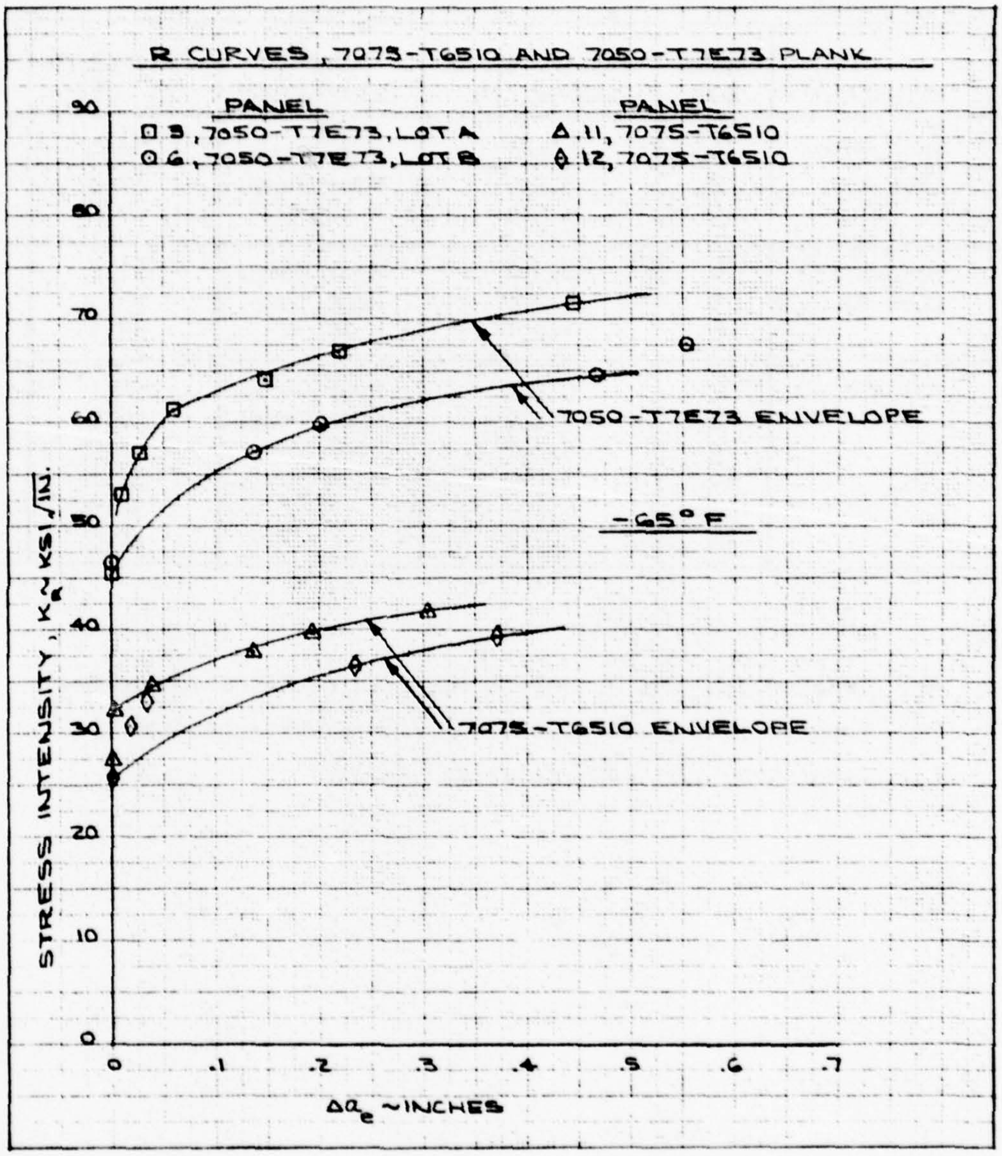

Figure 30 R-Curve Data For 7075-T6510 and 7050-T7E73 Wing Plank at -65°F

TABLE 10 FRACTURE TOUGHNESS SPECIMEN TEST CONDITIONS(1) AND RESULTS

MATERIAL(2)	PANEL NO.	INITIAL CRACK LENGTH, IN.	TEST(3) TEMPERATURE	K APPARENT KSI $\sqrt{IN.}$	K_c KSI $\sqrt{IN.}$
7050-T7E73 (Lot A)	1	5.601	Room Temp.	86.3	98.9
	2	5.297	Room Temp.	87.8	97.6
	3	5.301	-65°F	67.5	76.1
7050-T7E73 (Lot B)	4	5.304	Room Temp.	81.8	99.2
	5	5.292	Room Temp.	83.9	97.7
	6	5.298	-65°F	62.5	73.4
7075-T6510	7	5.317	Room Temp.	52.1	58.8
	8	5.297	Room Temp.	46.2	52.6
	9	5.302	Room Temp.	50.2	57.0
	10	5.295	Room Temp.	51.1	56.0
	11	5.30	-65°F	38.9	41.9
	12	5.303	-65°F	38.5	43.9

(1) Panel width = 16.1 inches; Panel thickness = .09 inches

(2) Longitudinal grain direction, wing plank extrusion

(3) Laboratory air ≈40% relative humidity

S_{max} = Maximum gross area stress

c_i = 1/2 initial crack length

w = Width of panel

c_{cr} = 1/2 critical effective crack length

The K_c values listed in Table 10 show a very significant improvement in the fracture toughness values of the 7050-T7E73 alloy over those of the 7075-T6510, in the order of 75% at room temperature and at -65°F. It may be noted, also, that the fracture toughness of 7050-T7E73 at -65°F is significantly higher than the value of 7075-T6510 at room temperature.

VI. CONCLUSIONS

The 7050-T7E73 extruded P-3 wing spar cap and plank shapes, produced and processed in production facilities have equivalent tensile and improved exfoliation resistance, stress corrosion resistance, and fatigue properties compared to identical 7075-T6510 extruded shapes.

Also, it was found that:

- o Crack propagation properties at room temperature of the 7050-T7E73 material were significantly improved over the 7075-T6510 material in lab air ($\approx$ 40% R.H.) and humid air ($\approx$ 98% R.H.) environments, with an increase of approximately 30% in the crack growth threshold and a decrease of approximately 67% in the crack growth rate.
- o Fracture toughness properties at room temperature and -65°F of the 7050-T7E73 material were 60 to 70% greater than those of the 7075-T6510 material. Fracture toughness of 7050-T7E73 at -65°F is approximately 30% higher than 7075-T6510 at room temperature.

Based upon a comparison of the above engineering properties, a substitution of the 7050-T7E73 for the 7075-T6510 extrusions would enhance the structural maintainability and durability of the P-3 series aircraft.

VII. RECOMMENDATIONS

Based upon the results of this program, it is recommended that appropriate material specifications and design allowables be established to permit the substitution of 7050-T7E73 extrusions for 7075-T6510 extrusions in the P-3 production aircraft.

REFERENCES

1. Rhodes, J. E., et al, "P-3A Service Life Extension Program (SLEP), Part I, Volume 2," LR 27982-2, Lockheed-California Company, Burbank, California, January 1977.

2. Pettit, D. E., "Experimental Techniques for Fracture Mechanics: Evaluation of Temperature Effects on R-Curve Behavior of Aluminum Sheet Materials," LR 28240, Lockheed-California Company, Burbank, California, December 1977.

APPENDIX A

Alcoa Information

Information and test data supplied by Aluminum Company of America are included in this Appendix.

ALUMINUM COMPANY OF AMERICA
1145 WILSHIRE BLVD., LOS ANGELES, CALIFORNIA 90017
(213) 483-2[illegible]
PAUL L. ABERNETHY, JR., District Sales Manager

ALCOA

July 9, 1976

Lockheed California Company
P. O. Box 551
Burbank, California 91520

Attention: Mr. George Wald

Gentlemen:

During a recent meeting you asked Alcoa's intentions to provide 7050 extrusions at the same strength level as 7075-T6. Below are listed the fracture toughness, stress-corrosion cracking and exfoliation characteristics Alcoa would agree to for the P-3 family of integrally stiffened panels with the same minimum tensile properties of the 7075-T6511 extrusion. This material would be designed as a 7050-T7EXX with the experimental temper designation to be selected if and when Lockheed agrees to this proposal. The following properties would apply to the 7050-T7EXX temper:

1. Minimum tensile mechanical properties identical with those of the current 7075-T6511, integrally stiffened P-3 panels.

2. Minimum fracture toughness (L-T direction) 23.0 Ksi SQ. RT. IN.; (T/L direction) 21.0 Ksi SQ. RT. IN.

3. Exfoliation corrosion less than or equal to that pictured in Photograph B Figure 2 of ASTM G34-72 at the T/10 plane was tested in accordance with ASTM G34.

4. Stress corrosion cracking resistance, C-Ring specimens shall be capable of passing a 20-day alternate immersion test per ASTM G47-46 when stressed in the short transverse direction at 20% of the guaranteed longitudinal yield strength.

This information has been passed on to Mr. Ed Balmuth, Naval Air Systems Command, for his analysis. It is my understanding that he feels these characteristics are satisfactory for P-3 applications. Regardless, we look forward to Lockheed's response to this proposal.

Very truly yours,

A S Kuhns

A. S. Kuhns

mal 5/2

ALUMINUM COMPANY OF AMERICA
1145 WILSHIRE BOULEVARD, LOS ANGELES, CALIFORNIA 90017
(213) 482-2680
PAUL L. ABERNETHY, JR.,

ALCOA

1977 December 16

Mr. Roy Brodie
Lockheed-California Company
P. O. Box 551
Burbank, California 91520

Dear Roy:

Attached is a summary of the mechanical property, fracture toughness, exfoliation and stress corrosion cracking tests conducted by the Alcoa Technical Center on the two lots of 7050-T7E73 wing planks, die no. 213562. I understand that you are interested in possibly attaching this data to your upcoming summary report. Please let me know if we can provide any additional information.

Very truly yours,

R. B. SHEPARD

mj 5/6

Attachment

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TABLE I.

PROPERTIES OF 7050-T7E73 EXTRUDED SHAPE # 213562

			TENSILE PROPERTIES T/2									ELECTRICAL CONDUCTIVITY % IACS	
			ENGLISH UNITS					S.I. UNITS					
LOT NO	S NO	LOCATION IN EXTRUSION	T.S. KSI	Y.S. KSI	EL %4D	R.A. %	Kc KSI√in	T.S. MPa	Y.S. MPa	EL %5D	Kc MPa√m	T/10	T/2
			LONGITUDINAL										
A38337	TESTED AT LAFAYETTE		85.6	76.5	14.5								38.6
			86.1	77.7	14.7								38.9
		AVG.	85.9	77.1	14.5								38.8
H32482A1	488009	W/4	86.1	78.1	13.6	36	30.0	594	538	12.2	33.0		
		W/2	85.2	77.4	14.3	36		587	534	12.2			
		3W/4	85.7	78.4	13.6	34	31.6	591	540	11.7	34.7	39.1	38.7
		AVG	85.7	78.0	13.8	35	30.8	591	538	12.0	33.8		
A38338	TESTED AT LAFAYETTE		86.6	78.0	14.0								38.6
			84.8	76.5	13.0								38.9
			85.7	77.2	13.5								38.8
H32483A1	488010	W/4	85.1	77.3	13.6	37	29.4	587	533	12.2	32.3		
		W/2	84.9	77.0	14.6	37		585	531	12.2		38.9	38.5
		3W/4	85.3	77.4	14.3	37	29.2	587	534	12.2	32.1		
		AVG	85.1	77.2	13.8	37	29.3	586	543	12.2	32.2		
			LONG-TRANSVERSE										
H32482A1	488009	W/4	83.7	76.3	13.6	36		577	526	12.2			
		W/2	83.9	76.1	14.3	29		579	525	13.3			
		3W/4	83.0	75.3	12.1	30		572	519	11.1			
		AVG	83.5	75.9	13.3	32		576	523	12.2			
H32483A1	488010	W/4	84.1	76.0	14.3	34		580	524	12.8			
		W/2	83.4	75.8	12.8	27		575	523	11.7			
		3W/4	83.4	75.2	11.4	31		575	518	11.7			
		AVG.	83.6	75.7	12.8	31		576	522	11.9			

ACCELERATED CORROSION TESTS - SPECIMENS FROM W/4 & 3W/4 LOCATIONS

		EXFOLIATION EXCO TEST				STRESSED SPECIMENS EXPOSED TO 3.5% NaCl A.I. (ASTM G44-75)											
						LONGITUDINAL T.B.				SHORT TRANSVERSE C-RINGS							
		24 HR.		48 HR		241 MPa (35 KSI)		138 MPa (20 KSI)		172 MPa (25 KSI)		138 MPa (20 KSI)		103 MPa (15 KSI)		69 MPa (10 KSI)	
LOT NO	S NO	T/10	T/2	T/10	T/2	F/N(1)	DAYS	F/N(1)	DAYS	F/N(1)	DAYS	F/N(1)	DAYS	F/N(1)	DAYS	F/N(1)	DA
H32482A1	488009	EA	EB	EA	EB	0/3	OK47	0/3	OK47	0/4	OK47	0/4	OK47	0/4	OK47	0/4	OK4
H32483A1	488010	EA	EB	EA	EB	0/3	OK47	0/3	OK47	0/4	OK47	0/4	OK47	0/4	OK47	0/4	OK

	COMPOSITION - WEIGHT PERCENT								
LOT NO	ZN	MG	CU	FE	SI	MN	CR	ZR	TI
A38337	6.35	2.43	2.03	0.08	0.05	0.00	0.01	0.10	0.042
A38338	6.67	2.48	2.09	0.09	0.07	0.00	0.00	0.10	0.040

NOTES

(1) F/N DENOTES NUMBER OF SPECIMENS FAILED OVER NUMBER OF SPECIMENS TESTED

TENSILE TESTS: 0.357" φ LONGITUDINAL & LONG-TRANSVERSE TAPERED SEAT TENSILE SPECS.

FRACTURE TOUGHNESS TESTS: 0.75" THICK LT COMPACT TENSION FRACTURE TOUGHNESS SPECIMENS

CORROSION TESTS: 0.125" φ LONGITUDINAL THREADED END TENSILE SPECIMENS & 0.75" φ SHORT-TRANSVERSE C-RINGS

YIELD STRENGTH = 0.2% OFFSET

H.T. NO. 083177C

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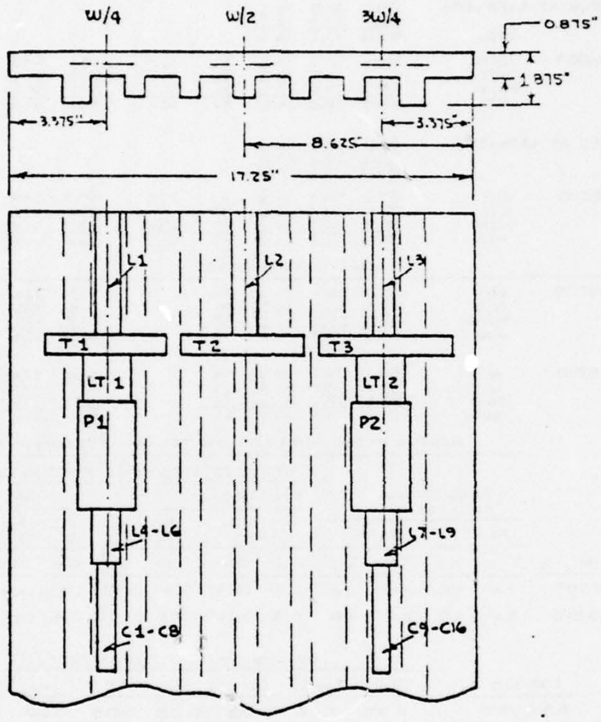

L1-L3, T1-T3	0.357" ϕ Tapered Seat Tensile Specimens
L4-L9	0.125" ϕ Threaded End Tensile Specimens
LT1, LT2	0.75" Thick Compact Tension Fracture Toughness Specimens
C1-C16	0.75" ϕ Short-Transverse C-Rings
P1-P2	2" x 4" Panels for Exfoliation Tests

LOCATION OF SPECIMENS IN 7050-T7E73 EXTRUDE SECTION #213562
S-488009, 488010

APPENDIX B

Spectra Fatigue Tabular Data

Tabular test data for flight-by-flight spectra fatigue tests are included in this Appendix.

The test data locations for the spectra fatigue specimens are shown in the following table:

Specimen[1] No.	Location, Page	Specimen[1] No.	Location, Page
5M21	B-2	LB5	B-18
5M22	B-2	LB6	B-19
LA1	B-3	LTB1	B-20
LA2	B-4	LTB2	B-21
LB1	B-5	5S41	B-22
LB2	B-6	5S42	B-13
5S21	B-7	LA7	B-20
5S22	B-8	LA8	B-23
LA3	B-9	LTA3	B-24
LA4	B-10	LTA4	B-27
LB3	B-11	LT3	B-18
LB4	B-11	LT4	B-19
7M21	B-5	LTB3	B-25
7M22	B-6	LTB4	B-21
L1	B-3	7M41	B-12
L2	B-4	7M42	B-26
7S21	B-7	L5	B-25
7S22	B-8	L6	B-23
L3	B-9	LT1	B-24
L4	B-10	LT2	B-17
5M41	B-12	7S41	B-22
5M42	B-13	7S42	B-26
LA5	B-14	L7	B-14
LA6	B-15	L8	B-15
LTA1	B-16	LB8	B-16
LTA2	B-17	LB7	Overloaded

(1) For test specimen description, see Table 7.

FATIGUE TEST DATA FOR SPECIMEN NO. 5M21				
K_t=2.7 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	35,000	175,000	.04	00
LONG. GRAIN	36,000	180,000	.08	.03
MACHINE, ETCH AND	37,000	185,000	.10	.05
CHEMICAL FILM	38,000	190,000	.14	.06
	39,000	195,000	.15	.08
	40,000	200,000	.18	.12
	41,000	205,000	.21	.16
	42,000	210,000	.24	.18
	43,000	215,000	.27	.25
	44,000	220,000	.33	.30
	45,000	225,000	.37	.35
	45,800	229,000	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. 5M22				
K_t=2.7 S.F.=1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	24,000	120,000	00	.02
LONG. GRAIN	25,000	125,000	00	.05
MACHINE, ETCH AND	26,000	130,000	00	.11
CHEMICAL FILM	27,000	135,000	00	.13
	28,000	140,000	00	.15
	29,000	145,000	00	.18
	30,000	150,000	00	.20
	31,000	155,000	00	.24
	32,000	160,000	00	.25
	33,000	165,000	00	.27
	34,000	170,000	00	.36
	35,000	175,000	.08	.42
	36,000	180,000	.14	.48
	37,109	185,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. LA1				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	8,000	40,000	.01	.01
LONG. GRAIN	9,000	45,000	.01	.01
MACHINE, ETCH AND	10,000	50,000	.02	.03
CHEMICAL FILM	11,000	55,000	.04	.06
	12,000	60,000	.08	.11
	13,000	65,000	.10	.15
	14,000	70,000	.13	.19
	15,000	75,000	.16	.23
	16,000	80,000	.21	.30
	17,000	85,000	.29	.40
	17,109	85,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. L1				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	8,000	40,000	.04	.02
LONG. GRAIN	9,000	45,000	.06	.06
MACHINE, ETCH AND	10,000	50,000	.09	.10
CHEMICAL FILM	11,000	55,000	.12	.13
	12,000	60,000	.19	.19
	13,000	65,000	.25	.26
	14,000	70,000	.30	.31
	14,404	72,020	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. L2				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	10,000	50,000	.04	
LONG. GRAIN	11,000	55,000	.06	.04
MACHINE, ETCH AND	12,000	60,000	.10	.08
CHEMICAL FILM	13,000	65,000	.10	.09
	14,000	70,000	.14	.12
	15,000	75,000	.18	.16
	16,000	80,000	.22	.21
	17,000	85,000	.26	.25
	18,000	90,000	.36	.34
	18,109	90,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. LA2				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	11,000		.01	00
LONG. GRAIN	12,000		.01	00
MACHINE, ETCH AND	13,000		.02	00
CHEMICAL FILM	14,000		.04	.04
	15,000		.05	.06
	16,000		.07	.09
	17,000		.10	.11
	18,000		.12	.14
	19,000		.14	.18
	20,000		.18	.22
	21,000		.22	.28
	22,000		.24	.28
	23,000		.26	.28
	24,000		.30	.38
	24,871		FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LB1				
K_t = 2.7 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	8,000	40,000	00	.01
LONG. GRAIN	9,000	45,000	00	.01
MACHINE, ETCH AND	10,000	50,000	00	.05
CHEMICAL FILM	11,000	55,000	00	.10
	12,000	60,000	.01	.10
	13,000	65,000	.03	.12
	14,000	70,000	.06	.14
	15,000	75,000	.10	.18
	16,000	80,000	.14	.20
	17,000	85,000	.18	.26
	18,000	90,000	.26	.34
	18,980	94,900	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 7M21				
K_t = 2.7 SF = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	10,000	50,000	.04	00
LONG. GRAIN	11,000	55,000	.10	.02
MACHINE, ETCH AND	12,000	60,000	.10	.10
CHEMICAL FILM	13,000	65,000	.11	.11
	14,000	70,000	.12	.13
	15,000	75,000	.14	.14
	16,000	80,000	.18	.16
	17,000	85,000	.22	.20
	18,000	90,000	.26	.27
	19,000	95,000	.28	.28
	20,000	100,000	.34	.34
	21,000	105,000	.36	.34
	22,473	112,365	FAILURE	

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FATIGUE TEST DATA FOR SPECIMEN No. LB2				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	17,000	85,000	.04	00
LONG. GRAIN	18,000	90,000	.08	00
MACHINE, ETCH AND	19,000	95,000	.10	.03
CHEMICAL FILM	20,000	100,000	.14	.06
	21,000	105,000	.16	.10
	22,000	110,000	.20	.15
	23,000	115,000	.22	.20
	24,000	120,000	.24	.20
	25,000	125,000	.28	.24
	26,000	130,000	.34	.27
	27,000	135,000	.46	.28
	28,109	140,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 7M22				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	11,000	55,000	00	.01
LONG. GRAIN	14,000	70,000	.01	.03
MACHINE, ETCH AND	15,000	75,000	.01	.04
CHEMICAL FILM	16,000	80,000	.06	.08
	17,000	85,000	.08	.12
	18,000	90,000	.10	.14
	19,000	95,000	.12	.16
	20,000	100,000	.16	.18
	21,000	105,000	.20	.22
	22,000	110,000	.22	.24
	23,000	115,000	.27	.29
	24,000	120,000	.28	.29
	26,000	130,000	.34	.32
	27,000	135,000	.36	.34
	28,921	144,605	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 7S21				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	19,000	95,000	00	.05
LONG. GRAIN	20,000	100,000	00	.07
MACHINE, SHOT PEEN, ETCH	21,000	105,000	00	.11
AND CHEMICAL FILM	22,000	110,000	00	.18
	23,000	115,000	00	.22
	24,000	120,000	00	.25
	25,000	125,000	.07	.32
TEST STOPPED @	26,000	130,000	.12	.36

FATIGUE TEST DATA FOR SPECIMEN No. 5S21				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	21,000	105,000	00	.04
LONG. GRAIN	22,000	110,000	00	.10
MACHINE, SHOT PEEN, ETCH	23,000	115,000	00	.14
AND CHEMICAL FILM	24,000	120,000	.12	.16
	25,000	125,000	.16	.20
TEST STOPPED @	26,000	130,000	.22	.27

FATIGUE TEST DATA FOR SPECIMEN No. 5S22				
K_t=2.7 S.F.=1.23	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	30,000	150,000	.04	00
LONG. GRAIN	31,000	155,000	.08	00
MACHINE, SHOT PEEN, ETCH	32,000	160,000	.14	00
AND CHEMICAL FILM	33,000	165,000	.18	.01
	34,000	170,000	.20	.10
	35,000	175,000	—	—
	36,000	180,000	.29	.18
	37,000	185,000	.36	.24
	38,000	190,000	.38	.26
	39,000	195,000	.48	.28
	39,109	195,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 7S22				
K_t=2.7 S.F.=1.23	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	33,000	165,000	00	.01
LONG. GRAIN	34,000	170,000	00	.06
MACHINE, SHOT PEEN, ETCH	36,000	180,000	00	.15
AND CHEMICAL FILM	37,000	185,000	00	.16
	38,000	190,000	00	.16
	39,000	195,000	00	.26
	40,000	200,000	.04	.26
	41,000	205,000	.06	.32
	42,000	210,000	.12	.36
	43,000	215,000	.18	.42
	43,109	215,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. L3				
K_t = 2.7 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	9,000	45,000	.02	00
LONG. GRAIN	10,000	50,000	.04	.03
MACHINE, SHOT PEEN, ETCH	11,000	55,000	.06	.12
AND CHEMICAL FILM	12,000	60,000	.10	.16
	13,000	65,000	.12	.20
	14,000	70,000	.18	.26
	15,000	75,000	.24	.28
	15,319	76,595	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. LA3				
K_t = 2.7 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	12,000	60,000	00	.06
LONG. GRAIN	13,000	65,000	.03	.09
MACHINE, SHOT PEEN, ETCH	14,000	70,000	.10	.12
AND CHEMICAL FILM	15,000	75,000	.12	.16
	16,000	80,000	.17	.24
	17,000	85,000	.20	.27
	18,000	90,000	.26	.29
	19,000	95,000	.30	.32
	20,000	100,000	.40	.37
	20,428	102,140	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. L4				
K_t = 2.7 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	9,000	45,000	.08	.04
LONG. GRAIN	10,000	50,000	.12	.08
MACHINE, SHOT PEEN, ETCH	11,000	55,000	.18	.16
AND CHEMICAL FILM	12,000	60,000	.24	.22
	13,000	65,000	.30	.29
	14,000	70,000	.41	.40
	14,050	70,250	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. LA4				
K_t = 2.7 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	10,000	50,000	00	.03
LONG. GRAIN	11,000	55,000	00	.06
MACHINE, SHOT PEEN, ETCH	12,000	60,000	.04	.10
AND CHEMICAL FILM	13,000	65,000	.16	.19
	14,000	70,000	.20	.19
	15,000	75,000	.21	.20
	16,000	80,000	.22	.26
	17,000	85,000	.26	.30
	18,000	90,000	.32	.34
	18,447	92,235	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LB3				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	13,000	65,000	00	.04
LONG. GRAIN	14,000	70,000	.04	.08
MACHINE, SHOT PEEN, ETCH	15,000	75,000	.10	.14
AND CHEMICAL FILM	16,000	80,000	.14	.18
	17,000	85,000	.21	.24
	18,000	90,000	.30	.31
	18,957	94,785	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LB4				
$K_t = 2.7$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	14,000	70,000	00	.01
LONG. GRAIN	15,000	75,000	.02	.05
MACHINE, SHOT PEEN, ETCH	16,000	80,000	.05	.10
AND CHEMICAL FILM	17,000	85,000	.08	.13
	18,000	90,000	.14	.20
	19,000	95,000	.20	.22
TEST STOPPED @	20,000	100,000	.26	.30

FATIGUE TEST DATA FOR SPECIMEN No. 7M41				
$K_t = 4.0$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	3,000	15,000	.06	.07
LONG. GRAIN	4,000	20,000	.08	.09
MACHINE, ETCH AND	5,000	25,000	.14	.12
CHEMICAL FILM	6,000	30,000	.17	.16
	7,000	35,000	.20	.18
	8,000	40,000	.23	.23
	9,000	45,000	.24	.28
	10,000	50,000	.33	.35
	10,723	53,615	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 5M41				
$K_t = 4.0$ S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	4,000	20,000	.05	.03
LONG. GRAIN	5,000	25,000	.08	.06
MACHINE, ETCH AND	6,000	30,000	.12	.10
CHEMICAL FILM	7,000	35,000	.16	.15
	8,000	40,000	.18	.18
	9,000	45,000	.22	.23
	10,000	50,000	.30	.28
	11,000	55,000	.38	.34
	11,574	57,870	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 5S42				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	7,000	35,000	.03	.02
LONG. GRAIN	8,000	40,000	.07	.06
MACHINE, SHOT PEEN, ETCH	9,000	45,000	.12	.11
AND CHEMICAL FILM	10,000	50,000	.14	.12
	11,000	55,000	.21	.20
	12,000	60,000	.26	.26
	13,000	65,000	.31	.30
	14,000	70,000	.36	.30
	14,100	70,500	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 5M42				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	7,000	35,000	.07	.08
MACHINE, ETCH AND	8,000	40,000	.08	.08
CHEMICAL FILM	9,000	45,000	.10	.11
	10,000	50,000	.12	.15
	11,000	55,000	.13	.16
	12,000	60,000	.19	.20
	13,000	65,000	.26	.30
	14,000	70,000	.34	.42
	14,109	70,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LA5				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	6000	30,000	.05	.04
LONG. GRAIN	7,000	35,000	.06	.05
MACHINE, ETCH AND	8,000	40,000	.08	.08
CHEMICAL FILM	9,000	45,000	.09	.09
	10,000	50,000	.13	.09
	11,000	55,000	.16	.12
	12,000	60,000	.20	.14
	13,000	65,000	.24	.16
	14,000	70,000	.26	.20
	15,000	75,000	.32	.22
	16,000	80,000	.38	.26
	16,298	81,490	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. L7				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	6,000	30,000	.08	.10
LONG. GRAIN	7,000	35,000	.08	.12
MACHINE, SHOT PEEN, ETCH	8,000	40,000	.18	.18
AND CHEMICAL FILM	9,000	45,000	.21	.20
	10,000	50,000	.26	.24
	11,000	55,000	.32	.27
	11,304	56,520	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. L8				
K_t=4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	5,000	25,000	.03	.07
LONG. GRAIN	6,000	30,000	.03	.10
MACHINE, SHOT PEEN, ETCH	7,000	35,000	.10	.12
AND CHEMICAL FILM	8,000	40,000	.12	.17
	9,000	45,000	.15	.22
	10,000	50,000	.23	.27
	11,000	55,000	.29	.33
	11,470	57,350	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LA6				
K_t=4.0 S.F.=1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	5,000	25,000	.04	.02
LONG. GRAIN	6,000	30,000	.04	.03
MACHINE, ETCH AND	7,000	35,000	.04	.04
CHEMICAL FILM	8,000	40,000	.06	.04
	9,000	45,000	.11	.10
	10,000	50,000	.12	.11
	11,000	55,000	.14	.12
	12,000	60,000	.23	.12
	13,000	65,000	.23	.16
	14,000	70,000	.27	.23
	15,000	75,000	.30	.23
	16,000	80,000	.38	.30
TEST STOPPED @	17,000	85,000	.40	.30

FATIGUE TEST DATA FOR SPECIMEN No. LTA1				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	6,000	30,000	00	.03
LONG. TRANS. GRAIN	7,000	35,000	.06	.08
MACHINE, ETCH AND	8,000	40,000	.06	.09
CHEMICAL FILM	9,000	45,000	.10	.12
	10,000	50,000	.10	.15
	11,000	55,000	.14	.16
	12,000	60,000	.18	.20
	13,000	65,000	.24	.26
	14,000	70,000	.28	.31
	15,000	75,000	.34	.36
	15,109	75,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LB8				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	5,000	25,000	00	.01
LONG. GRAIN	6,000	30,000	.02	.07
MACHINE, SHOT PEEN, ETCH	7,000	35,000	.10	.11
AND CHEMICAL FILM	8,000	40,000	.16	.18
	9,000	45,000	.18	.21
TEST STOPPED @	9,356	46,780	—	—

FATIGUE TEST DATA FOR SPECIMEN No. LT2				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	4,000	20,000	.05	.06
LONG. TRANS. GRAIN	5,000	25,000	.07	.10
MACHINE, ETCH AND	6,000	30,000	.10	.11
CHEMICAL FILM	7,000	35,000	.15	.13
	8,000	40,000	.18	.17
TEST STOPPED @	9,000	45,000	.22	.22

FATIGUE TEST DATA FOR SPECIMEN No. LTA2				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	5,000	25,000	.04	.02
LONG. TRANS. GRAIN	6,000	30,000	.05	.02
MACHINE, ETCH AND	7,000	35,000	.06	.03
CHEMICAL FILM	8,000	40,000	.06	.06
	9,000	45,000	.10	.10
	10,000	50,000	.13	.14
	11,000	55,000	.16	.17
	12,000	60,000	.21	.19
TEST STOPPED @	13,000	65,000	.24	.23

FATIGUE TEST DATA FOR SPECIMEN No. LB5				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	5,000	25,000	.03	.03
LONG. GRAIN		OVERLOADED		
MACHINE, ETCH AND				
CHEMICAL FILM				

FATIGUE TEST DATA FOR SPECIMEN No. LT3				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	4,000	20,000	.03	.03
LONG. TRANS. GRAIN	5,000	25,000	.05	.05
MACHINE, SHOT PEEN, ETCH		OVERLOADED		
AND CHEMICAL FILM				

FATIGUE TEST DATA FOR SPECIMEN NO. LT4

$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	4,000	20,000	.02	00
LONG. TRANS. GRAIN	6,000	30,000	.08	.04
MACHINE, SHOT PEEN, ETCH	7,000	35,000	.09	.12
AND CHEMICAL FILM	8,000	40,000	.16	.16
	9,000	45,000	.20	.18
TEST STOPPED @	10,000	50,000	.27	.26

FATIGUE TEST DATA FOR SPECIMEN NO. LB6

$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	4,000	20,000	.04	.01
LONG. GRAIN	5,000	25,000	.04	.03
MACHINE, ETCH AND	6,000	30,000	.04	.05
CHEMICAL FILM	7,000	35,000	.07	.08
	8,000	40,000	.08	.10
	9,000	45,000	.10	.12
	10,000	50,000	.12	.15
	11,000	55,000	.14	.17
	12,000	60,000	.16	.20
TEST STOPPED @	13,000	65,000	.21	.23

FATIGUE TEST DATA FOR SPECIMEN NO. LTB1				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	5,000	25,000	00	.02
LONG. TRANS. GRAIN	6,000	30,000	.06	.06
MACHINE, ETCH AND	7,000	35,000	.08	.08
CHEMICAL FILM	8,000	40,000	.12	.10
	9,000	45,000	.13	.13
	10,000	50,000	.15	.16
	11,000	55,000	.18	.18
	12,000	60,000	.22	.21
	13,000	65,000	.30	.28
	14,000	70,000	.35	.33
	15,000	75,000	.40	.37
	15,109	75,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. LA7				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	6,000	30,000	.03	.06
LONG. GRAIN	7,000	35,000	.10	.10
MACHINE, SHOT PEEN, ETCH	8,000	40,000	.12	.13
AND CHEMICAL FILM	9,000	45,000	.20	.20
	10,000	50,000	.24	.24
	11,000	55,000	.27	.31
	11,600	58,000	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LTB4				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	5,000	25,000	.04	.02
LONG. TRANS. GRAIN	6,000	30,000	.07	.08
MACHINE, SHOT PEEN, ETCH	7,000	35,000	.08	.12
AND CHEMICAL FILM	8,000	40,000	.14	.14
	9,000	45,000	.15	.15
	10,000	50,000	.22	.18
TEST STOPPED @	11,000	55,000	.25	.20

FATIGUE TEST DATA FOR SPECIMEN No. LTB2				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	4,000	20,000	.02	00
LONG. TRANS. GRAIN	5,000	25,000	.04	00
MACHINE, ETCH AND	6,000	30,000	.06	.04
CHEMICAL FILM	7,000	35,000	.06	.04
	8,000	40,000	.09	.06
	9,000	45,000	.12	.09
	10,000	50,000	.12	.13
	11,000	55,000	.16	.16
	12,000	60,000	.18	.18
TEST STOPPED @	13,000	65,000	.22	.21

FATIGUE TEST DATA FOR SPECIMEN No. 5S41				
K_t = 4.0 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7050-T7E73 SPAR CAP	4,000	20,000	.04	.06
LONG. GRAIN	5,000	25,000	.14	.11
MACHINE, SHOT PEEN, ETCH	6,000	30,000	.13	.15
AND CHEMICAL FILM	7,000	35,000	.14	.16
	8,000	40,000	.19	.21
	9,000	45,000	.26	.32
	9,615	48,075	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 7S41				
K_t = 4.0 S.F. = 1.30	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	4,000	20,000	.10	.10
LONG. GRAIN	5,000	25,000	.14	.14
MACHINE, SHOT PEEN, ETCH	6,000	30,000	.20	.22
AND CHEMICAL FILM	7,000	35,000	.26	.28
	8,000	40,000	.30	.38
	8,057	40,285	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. L6				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	4,000	20,000	.05	.03
LONG. GRAIN	5,000	25,000	.08	.08
MACHINE, ETCH AND	6,000	30,000	.11	.11
CHEMICAL FILM		OVERLOADED		

FATIGUE TEST DATA FOR SPECIMEN NO. LA8				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	4,000	20,000	00	.01
LONG. GRAIN	5,000	25,000	00	.06
MACHINE, SHOT PEEN, ETCH	6,000	30,000	.02	.09
AND CHEMICAL FILM		OVERLOADED		

FATIGUE TEST DATA FOR SPECIMEN No. LTA3				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	5,000	25,000	00	.02
LONG. TRANS. GRAIN	6,000	30,000	.05	.06
MACHINE, SHOT PEEN, ETCH	7,000	35,000	.06	.08
AND CHEMICAL FILM	8,000	40,000	.12	.10
	9,000	45,000	.18	.16
	10,000	50,000	.22	.20
	11,000	55,000	.30	.24
	12,000	60,000	.36	.32
	12,109	60,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LT1				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	4,000	20,000	.07	.05
LONG. TRANS. GRAIN	5,000	25,000	.09	.09
MACHINE, ETCH AND	6,000	30,000	.12	.13
CHEMICAL FILM	7,000	35,000	.16	.16
	8,000	40,000	.21	.24
	9,000	45,000	.24	.30
	9,383	46,915	FAILURE	

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FATIGUE TEST DATA FOR SPECIMEN NO. LTB3				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT B	5,000	25,000	00	.01
LONG. TRANS. GRAIN	6,000	30,000	.06	.07
MACHINE, SHOT PEEN, ETCH	7,000	35,000	.12	.11
AND CHEMICAL FILM	8,000	40,000	.16	.13
	9,000	45,000	.18	.17
	10,000	50,000	.22	.20
	11,000	55,000	.24	.23
	11,419	57,095	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN NO. L5				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 PLANK	4,000	20,000	.04	.06
LONG. GRAIN	5,000	25,000	.08	.09
MACHINE, ETCH AND	6,000	30,000	.12	.13
CHEMICAL FILM	7,000	35,000	.17	.16
	8,000	40,000	.20	.22
	9,000	45,000	.23	.25
	10,000	50,000	.27	.27
	11,000	55,000	.29	.30
	11,109	55,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 7S42				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	5,000	25,000	.02	00
MACHINE, SHOT PEEN, ETCH	6,000	30,000	.07	.02
AND CHEMICAL FILM	7,000	35,000	.10	.05
LONG. GRAIN	8,000	40,000	.18	.09
	9,000	45,000	.20	.10
	10,000	50,000	.20	.14
	11,000	55,000	.24	.20
	12,000	60,000	.27	.23
	13,000	65,000	.30	.27
	14,000	70,000	.34	.30
	15,000	75,000	.36	.32
	15,463	77,315.	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. 7M42				
$K_t = 4.0$ S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7075-T6510 SPAR CAP	4,000	20,000	.04	.03
LONG. GRAIN	5,000	25,000	.05	.06
MACHINE, ETCH AND	6,000	30,000	.10	.10
CHEMICAL FILM	7,000	35,000	.16	.16
	8,000	40,000	.20	.20
	9,000	45,000	.24	.24
	10,000	50,000	.26	.26
	11,000	55,000	.36	.34
	11,109	55,545	FAILURE	

FATIGUE TEST DATA FOR SPECIMEN No. LTA4				
K_t = 4.0 S.F. = 1.15	FLIGHTS	HOURS	CRACKING	
7050-T7E73 PLANK, LOT A	4,000	20,000	00	.01
LONG. TRANS. GRAIN	6,000	30,000	.02	.04
MACHINE, SHOT PEEN, ETCH	7,000	35,000	.03	.04
AND CHEMICAL FILM	8,000	40,000	.05	.08
	9,000	45,000	.14	.11
	10,000	50,000	.18	.19
TEST STOPPED @	11,000	55,000	.23	.26

APPENDIX C

Crack Propagation Tabular Data

Tabular test data for constant amplitude crack propagation tests are included in this Appendix.

The test data locations for the crack propagation specimens are shown in the following table:

Specimen[1] No.	Location, Page	Specimen[1] No.	Location, Page
1	C-2	7	C-9 & 10
2	C-3 & 4	8	C-11 & 12
4	C-5 & 6	9	C-13 & 14
5	C-7 & 8	10	C-15 & 16

(1) For test specimen description, see Table 9.

AD-A058 002 LOCKHEED-CALIFORNIA CO BURBANK F/G 11/6

COMPARISON OF ENGINEERING PROPERTIES OF 7050-T7E73 AND 7075-T65--ETC(U)

FEB 78 R W BRODIE, L BAKOW N62269-77-C-0024

UNCLASSIFIED LR-28499 NADC-76269-30 NL

2 OF 2

AD A058 002

END

DATE FILMED

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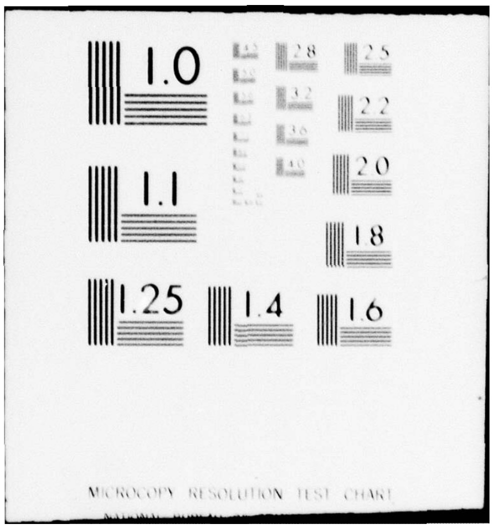
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2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

CONSTANT AMPLITUDE CRACK GROWTH DATA FOR PANEL NO. 1				
7050-T7E73 LOT A	ΣN	CRACKING		
TESTED IN LAB AIR	(CYCLES)	a_1	NOTCH	a_2
(≈ 40 % RELATIVE HUMIDITY)		(INCHES)	(INCHES)	(INCHES)
R.T.	5,000	.021	2.00	.021
6 HZ R = .1	10,000	.051		.051
WIDTH = 16.10 INCHES	14,000	.075		.084
THICKNESS = .0915 INCHES	16,000	.087		.099
GROSS AREA STRESS = 6.79 KSI →	17,500	.093		.107
	19,000	.128		.144
	23,000	.213		.241
	27,000	.300		.341
	31,000	.397		.446
	35,000	.521		.585
	39,000	.655		.723
	42,000	.774		.835
	45,000	.890		.962
GROSS AREA STRESS = 10.18 KSI →	48,000	1.040		1.098
	50,000	1.141		1.200
	52,000	1.251		1.312
	54,000	1.370		1.438
	55,000	1.465		1.543
	56,500	1.581		1.653
	58,000	1.694		1.771
	58,700	1.764	2.00	1.837

CONSTANT AMPLITUDE CRACK GROWTH DATA FOR PANEL NO. 2

7050-T7E73 LOT A	ΣN	CRACKING		
TESTED IN 98% RELATIVE	(CYCLES)	a_1	NOTCH	a_2
HUMIDITY		(INCHES)	(INCHES)	(INCHES)
R.T.	40,000	.001	2.00	.012
6 HZ R=.1	43,000	.026		.015
WIDTH = 16.09 INCHES	53,000	.035		.018
THICKNESS = .0945 INCHES	58,000	.042		.018
GROSS AREA STRESS = 4.0 KSI →	68,000	.042		.028
	73,000	.053		.032
	98,000	.064		.034
	113,000	.068		.040
	133,000	.073		.052
	150,000	.084		.052
	170,000	.097		.052
	190,000	.107		.062
	210,000	.127		.064
	259,000	.150		.081
	270,000	.158		.090
	275,000	.174		.101
	285,000	.194		.129
	292,000	.235		.149
	297,000	.265		.171
	304,000	.291		.189
	311,000	.320		.206
GROSS AREA STRESS = 5.50 KSI →	318,000	.340		.227
	325,000	.363		.247
	332,000	.389		.270
	339,000	.421		.291
	346,000	.445		.311
	353,000	.477		.337
	360,000	.501		.358
	367,000	.529		.383
(CONT'D NEXT PAGE)	374,000	.555	2.00	.408

CONSTANT AMPLITUDE CRACK GROWTH DATA FOR PANEL NO. 2				
(CONTINUED)	ΣN	CRACKING		
	(CYCLES)	a_1	NOTCH	a_2
		(INCHES)	(INCHES)	(INCHES)
GROSS AREA STRESS = 5.50 KSI	381,000	.584	2.00	.430
	388,000	.617		.453
	395,000	.643		.481
	402,000	.677		.507
	409,000	.706	2.00	.538

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CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL No.4				
7050-T7E73 LOT B	ΣN	CRACKING		
TESTED IN LAB AIR	(CYCLES)	a_1	NOTCH	a_2
(≈40% RELATIVE HUMIDITY)		(INCHES)	(INCHES)	(INCHES)
R.T.	15,000	.005	2.00	.009
6 Hz. R=.1	30,000	.025		.017
WIDTH = 16.10 INCHES	50,000	.042		.033
THICKNESS = .0954 INCHES	80,000	.059		.053
GROSS AREA STRESS = 4.0 KSI	120,000	.087		.068
	170,000	.115		.072
	210,000	.145		.090
	260,000	.172		.110
	310,000	.203		.127
	374,000	.236		.156
	424,000	.265		.170
	470,000	.301		.187
	480,000	.335		.221
	490,000	.369		.254
	500,000	.403		.290
GROSS AREA STRESS = 5.5 KSI	510,000	.445		.321
	525,000	.500		.377
	540,000	.555		.431
	560,000	.637		.513
	572,000	.686		.564
	574,000	.709		.588
	579,000	.766		.644
	584,000	.810		.706
GROSS AREA STRESS = 7.0 KSI	589,000	.870		.768
	595,000	.940		.854
	601,000	1.022		.947
	606,000	1.097		1.038
	609,000	1.150	2.00	1.098
(CONT'D NEXT PAGE)				

CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL No.4

(CONTINUED)	ΣN (CYCLES)	CRACKING a_1 (INCHES)	NOTCH (INCHES)	a_2 (INCHES)
	609,300	1.156	2.00	1.109
GROSS AREA STRESS = 10.0 KSI	609,600	1.171		1.127
	610,200	1.203		1.166
	610,800	1.239		1.206
	611,300	1.273		1.243
	611,800	1.282		1.255
	612,300	1.297		1.267
	612,800	1.321		1.292
	613,300	1.330		1.307
GROSS AREA STRESS = 8.0 KSI	613,800	1.346		1.321
	614,800	1.376		1.349
	615,800	1.409		1.380
	616,800	1.433		1.409
	617,800	1.467		1.440
	618,800	1.495		1.470
	621,800	1.521		1.496
	623,800	1.548		1.519
	625,800	1.564		1.548
	626,800	1.587		1.558
GROSS AREA STRESS = 6.0 KSI	627,800	1.599		1.571
	628,800	1.615		1.586
	629,800	1.628		1.599
	630,800	1.650		1.618
	631,800	1.662		1.629
	632,300	1.670	2.00	1.634

CONSTANT AMPLITUDE CRACK GROWTH DATA FOR PANEL No. 5				
7050-T7E73 LOT B	ΣN	CRACKING		
TESTED IN 98% RELATIVE HUMIDITY	(CYCLES)	a_1 (INCHES)	NOTCH (INCHES)	a_2 (INCHES)
R.T.	20,000	.017	2.00	.026
6Hz R=.1	30,000	.028		.039
WIDTH = 16.08 INCHES	45,000	.040		.064
THICKNESS = .096 INCHES	60,000	.052		.090
GROSS AREA STRESS = 4.0 KSI	70,000	.061		.107
	80,000	.071		.124
	90,000	.081		.136
	100,000	.092		.156
	102,000	.094		.167
	105,000	.108		.185
	114,000	.142		.220
	124,000	.180		.269
	134,000	.226		.324
GROSS AREA STRESS = 5.5 KSI	144,000	.267		.362
	154,000	.318		.412
	169,000	.395		.493
	184,000	.476		.575
	194,000	.545		.633
	200,000	.588		.668
	202,000	.639		.715
	204,000	.688		.757
	206,000	.746		.803
	208,000	.806		.851
GROSS AREA STRESS = 7.0 KSI	210,000	.864		.912
	212,000	.926		.967
	214,000	.987		1.026
	216,000	1.055		1.088
	217,300	1.092	2.00	1.127
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CONSTANT AMPLITUDE CRACK GROWTH DATA FOR PANEL No.5				
(CONTINUED)	ΣN	CRACKING		
	(CYCLES)	a_1	NOTCH	a_2
		(INCHES)	(INCHES)	(INCHES)
	217,800	1.119	2.00	1.155
	218,300	1.142		1.179
	218,800	1.182		1.209
	219,300	1.203		1.234
GROSS AREA STRESS = 8.0 KSI	219,800	1.239		1.265
	220,800	1.288		1.334
	221,800	1.352		1.396
	222,800	1.411		1.460
	223,800	1.485		1.533
	225,800	1.507		1.560
	226,800	1.530		1.589
GROSS AREA STRESS = 6.0 KSI	227,800	1.555		1.618
	228,800	1.584		1.651
	229,700	1.614	2.00	1.678

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CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL NO. 7				
7075-T6510	ΣN	CRACKING		
TESTED IN LAB AIR	(CYCLES)	a_1	NOTCH	a_2
(≈40% RELATIVE HUMIDITY		(INCHES)	(INCHES)	(INCHES)
R.T.	12,500	.015	2.00	.011
6 Hz. R=.1	26,000	.050		.032
WIDTH = 16.08 INCHES	40,000	.097		.053
THICKNESS = .0852 INCHES	60,000	.169		.089
GROSS AREA STRESS = 4.0 KSI	80,000	.232		.127
	100,000	.307		.187
	105,000	.363		.237
	109,000	.417		.280
	113,000	.463		.315
GROSS AREA STRESS = 5.5 KSI	117,000	.521		.364
	121,000	.584		.406
	125,000	.655		.455
	129,000	.730		.503
	129,500	.756		.528
	131,500	.821		.575
	133,500	.863		.618
GROSS AREA STRESS = 7.0 KSI	135,500	.962		.665
	137,500	1.027		.719
	139,500	1.127		.771
	141,500	1.213	2.00	.834
(CONT'D NEXT PAGE)				

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CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL NO. 7				
(CONTINUED)	ΣN	CRACKING		
	(CYCLES)	a_1	NOTCH	a_2
		(INCHES)	(INCHES)	(INCHES)
	142,000	1.249	2.00	.879
	142,500	1.286		.910
	143,000	1.337		.929
	143,500	1.426		.979
	144,000	1.466		1.003
GROSS AREA STRESS = 8.0 KSI	144,500	1.518		1.032
	145,000	1.563		1.048
	145,500	1.614		1.071
	146,000	1.663		1.105
	146,500	1.731		1.132
	147,000	1.802		1.170
	149,000	1.877		1.210
	149,500	1.903		1.215
	150,000	1.930		1.225
GROSS AREA STRESS = 6.0 KSI	150,500	1.952		1.235
	151,000	1.977		1.254
	151,500	2.001		1.258
	152,000	2.004	2.00	1.273

CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL No.8				
7075-T6510	ΣN	CRACKING		
TESTED IN LAB AIR	(CYCLES)	a_1	NOTCH	a_2
(≈ 40% RELATIVE HUMIDITY)		(INCHES)	(INCHES)	(INCHES)
R.T.	30,000	.017	2.00	00
6Hz. R = .1	40,000	.034		.021
WIDTH = 16.09 INCHES	50,000	.051		.034
THICKNESS = .0849 INCHES	60,000	.068		.048
	75,000	.094		.073
GROSS AREA STRESS = 3.0 KSI	90,000	.120		.098
	105,000	.153		.133
	120,000	.226		.160
	130,000	.246		.178
	140,000	.286		.203
	142,000	.297		.205
	143,000	.309		.210
	145,000	.326		.221
	148,000	.361		.250
	151,000	.393		.279
GROSS AREA STRESS = 4.5 KSI	154,000	.424		.315
	157,000	.456		.343
	160,000	.491		.378
	163,000	.523		.404
	167,000	.560	2.00	.435

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CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL NO. 8				
(CONTINUED)	ΣN	CRACKING		
	(CYCLES)	a_1	NOTCH	a_2
		(INCHES)	(INCHES)	(INCHES)
	168,000	.601	2.00	.497
	170,000	.637		.508
	172,000	.676		.547
	175,000	.726		.602
GROSS AREA STRESS = 5.5 KSI	178,000	.799		.653
	181,000	.866		.704
	184,000	.925		.761
	187,000	.995		.813
	190,000	1.064		.894
	191,000	1.098		.916
	192,000	1.151		.960
	193,000	1.199		.986
	194,000	1.232		1.033
	195,500	1.292		1.102
GROSS AREA STRESS = 6.5 KSI	197,000	1.357		1.162
	198,500	1.431		1.229
	200,000	1.504		1.300
	201,000	1.552		1.348
	202,000	1.606		1.409
	204,000	1.612		1.427
	205,000	1.632		1.451
	206,000	1.646		1.466
	207,000	1.670		1.493
	208,000	1.691		1.519
	209,000	1.710		1.542
	210,000	1.728		1.563
	210,200	1.732	2.00	1.565

CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL No. 9				
7075-T6510	ΣN	CRACKING		
TESTED IN 98 % RELATIVE	(CYCLES)	a_1	NOTCH	a_2
HUMIDITY		(INCHES)	(INCHES)	(INCHES)
R.T.	10,000	.010	2.00	.023
6 HZ. R = .1	20,000	.114		.065
WIDTH = 16.10 INCHES	23,000	.142		.085
THICKNESS = .0865 INCHES	25,000	.163		.098
GROSS AREA STRESS = 4.0 KSI	30,000	.187		.109
	35,000	.200		.120
	40,000	.225		.134
	45,000	.244		.153
GROSS AREA STRESS = 3.0 KSI	50,000	.265		.167
	55,000	.292		.181
	60,000	.311		.198
	65,000	.330		.217
	70,000	.367		.240
	72,000	.382		.253
	75,000	.419		.282
	78,000	.452		.313
GROSS AREA STRESS = 4.0 KSI	81,000	.490		.343
	83,000	.512		.366
	85,000	.534		.385
	87,000	.563		.414
	88,000	.580		.423
	89,000	.600		.446
	90,000	.628		.468
	91,000	.647		.492
GROSS AREA STRESS = 5.0 KSI	92,000	.665		.513
	94,000	.718		.563
	96,000	.769		.613
	97,000	.805		.644
	97,900	.823	2.00	.670
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CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL NO. 9

(CONTINUED)	ΣN	CRACKING		
	(CYCLES)	a_1	NOTCH	a_2
		(INCHES)	(INCHES)	(INCHES)
	98,400	.843	2.00	.687
	98,900	.863		.705
	99,400	.885		.730
	99,900	.905		.752
	100,400	.927		.781
	100,900	.950		.800
	101,400	.972		.816
GROSS AREA STRESS = 6.0 KSI	101,900	.995		.839
	102,400	1.016		.861
	102,900	1.035		.883
	103,400	1.068		.903
	103,900	1.074		.926
	104,900	1.074		.974
	105,900	1.074		1.018
	106,000	1.163		1.023
	106,150	1.169	2.00	1.030

CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL NO. 10				
7075-T6510	ΣN	CRACKING		
TESTED IN 98% RELATIVE	(CYCLES)	a_1	NOTCH	a_2
HUMIDITY		(INCHES)	(INCHES)	(INCHES)
R.T. R=.1	20,000	.009	1.968	.013
WIDTH = 16.08 INCHES	30,000	.016		.031
THICKNESS = .0856 INCHES	40,000	.018		.054
GROSS AREA STRESS = 3.0 KSI	50,000	.020		.069
	60,000	.023		.077
	70,000	.027		.092
	80,000	.027		.110
	90,000	.028		.124
	100,000	.028		.138
	110,000	.032		.151
	120,000	.038		.166
	140,000	.042		.195
	160,000	.056		.233
	180,000	.074		.293
	200,000	.086		.372
	215,000	.097		.444
	218,500	.152		.503
	220,000	.173		.527
	222,000	.201		.553
	224,000	.225		.588
GROSS AREA STRESS = 4.5 KSI	226,000	.251		.604
	228,000	.265		.620
	230,000	.290		.646
	232,000	.316		.688
	233,000	.334	1.968	.709
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CONSTANT AMPLITUDE CRACK GROWTH DATA, PANEL NO. 10				
(CONTINUED)	ΣN	CRACKING		
	(CYCLES)	a_1	NOTCH	a_2
		(INCHES)	(INCHES)	(INCHES)
	234,000	.360	1.968	.742
	235,000	.387		.783
	236,500	.437		.839
	238,000	.469		.893
GROSS AREA STRESS=5.5 KSI	239,500	.503		.956
	241,000	.548		1.014
	242,500	.593		1.079
	243,000	.631		1.137
	245,000	.693		1.219
	246,800	.743		1.290
	247,300	.775		1.329
	248,000	.811		1.376
	249,000	.867		1.448
	250,000	.916		1.514
GROSS AREA STRESS=6.5 KSI	251,000	.976		1.574
	252,000	1.045		1.645
	253,000	1.106		1.724
	254,000	1.188		1.797
	254,300	1.211		1.821
	256,300	1.238		1.856
	257,300	1.273		1.888
	258,300	1.298		1.922
	258,800	1.305		1.940
	259,300	1.326		1.960
	259,800	1.338		1.977
	260,100	1.345	1.968	1.982